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Railway Equipment Maintenance*

By L. D. Freeman†

Economical maintenance of equipment, over long periods of time, can be attained only by adopting carefully designed equipment, providing adequate repair facilities and properly directing the personnel

TRANSPORTATION was responsible for the vast development of our natural resources and the railways have made it possible for our people to enjoy the highest standard of living in the world.

A modern efficient transportation system is necessary to preserve our present economic and social life and to form the foundation of our National Defense.

Some idea of the magnitude of the equipment-maintenance problem is indicated by a recent inventory of railway equipment, consisting of 51,000 locomotives, 2,035,000 freight cars and 46,500 passenger-train cars, not including about 300,000 privately owned freight cars and 8,500 Pullman cars.

This equipment is spread over 247,000 miles of railways that include more than 427,000 miles of tracks.

Cost of Railway Operation

Reports of railway operations made to the Interstate Commerce Commission for the ten-year period, 1923 to 1932, inclusive, indicate that total railway operating revenues averaged $5,584,000,000 per year; corresponding operating expenses were $4,167,000,000, or 74.63 per cent of operating revenues. During this same period the maintenance of equipment expenses averaged approximately $1,128,000,000 per year, or 27.06 per cent of the total cost of railway operation.

Description and Value of Railroad Shops

There are 403 locomotive repair shops, 3,271 enginehouses and 568 freight- and passenger-car repair shops. The exact number now in operation is not known.

As of December 31, 1931, the book value, as new, of all shops and enginehouses was $678,700,000, and of shop machinery $320,500,000, making a total of $999,200,000, of which 67.9 per cent represented shops and enginehouses and 32.1 per cent represented shop machinery.

From June 30, 1914, to December 31, 1931, a period of 17.5 years, there was expended by all Class I railroads for additions and betterments $10,429,917,000 net, or an average of $595,995,000 per year, of which only $16,152,000, or 2.71 per cent, was expended for shops and enginehouses and $7,349,000, or 1.23 per cent, for shop machinery. A total of only 3.94 per cent of all addition-and-betterment money was expended for improving the facilities used to maintain equipment, the cost of such maintenance amounting to 27 per cent of all operating expenses.

Based upon the values indicated and the rate of expenditures for the 17.5-year period, the replacement cycle for shops and enginehouses has been 42 years, and for shop machinery, 43.6 years.

Assuming a uniform rate of renewals over the above period, the average age of shops and enginehouses is 21 years and of shop machinery, 21.8 years.

The accuracy of this statement is borne out by a recent survey of a large railroad shop in which the average

* A paper to be presented at the American Society of Mechanical Engineers semi-annual meeting at Cincinnati, Ohio, June 19-21, 1935, at a joint session of the Railroad and Machine Shop Practice Divisions.

The basic statistical data referred to in the text have been obtained from "Statistics of Railways in the United States" published by the Interstate Commerce Commission. Other valuable data have been obtained from reports issued by the Federal Co-ordinator of Transportation.

† Member of the A.S.M.E.

age of machine tools of known age was 19.68 years. (The age of only 74 per cent of the machine tools was known.)

Locomotive Repair Shops

With a few outstanding exceptions, where new shops were designed to take advantage of scientific principles of short, straight-line movements and mass production methods used by progressive manufacturers, in so far as they could be advantageously adapted to railroad repair work, repair shops are old, poorly equipped, inefficiently arranged and totally inadequate properly to repair modern motive power.

During the past 21 years, a period equal to the average age of all shops, the tractive force of locomotives has increased 48 per cent.

Enginehouses

The situation with respect to enginehouses is worse than that of locomotive repair shops. The increase in the length of locomotives from about 50 ft. to 120 ft., lack of proper track space, drop-pit tables and other facilities, arranged in such a manner as to expedite movement of locomotives through terminals, have resulted in much delay and high cost of handling, which, in the final analysis, necessitates owning enough additional locomotives to offset the time so lost.

Car Shops

Most of the freight-car repair work carried on by the railroads is done on "repair tracks" usually without shelter and lacking overhead cranes or other means for lifting cars and handling materials and parts. Such conditions naturally result in highly unsatisfactory performance, high cost and a great waste of car days. Each car day lost costs its owner $1.00.

Cause of Existing Shop Conditions

The present situation with respect to railroad repair shops, in general is the result of conditions brought about by the consolidation, in some cases many years ago, of numerous small railroads, each having had repair facilities probably suitable for its then existing individual requirements and to accommodate its small light-capacity locomotives and cars. In many of these cases the management has either failed to recognize the importance of the function of maintenance of equipment or was financially unable to remedy the situation, with the result that it has continued to use repair facilities hopelessly outgrown by greatly increased size of equipment units.

The natural result of using facilities unsuited, even if new, for repairs to equipment of sizes and weights not contemplated in the original design of the shops, has been excessive maintenance costs, which are now a matter of record.

Cost of Equipment Maintenance

The ledger value or original purchase price of all locomotives and cars is about $5,000,000,000.

Fifty-one thousand four-hundred twenty-five locomotives on hand at a recent inventory had a ledger value, when new, of $1,717,697,850, while the cost of repairs charged to I. C. C. Account 308 has averaged $400,000,000 per year for the ten years ended December 31, 1932.

Once each 4.29 years the amount expended for locomotive repairs was equal to the first cost of all the locomotives.

The average age of all locomotives is 20.7 years; therefore, the amount spent for repairs so far during their life is equal to 4.82 times their cost when new. At this rate the annual cost of repairs to the average locomotive is equal to 23.2 per cent of the first cost.

The 2,051,740 freight cars on hand July 1, 1933, had a ledger value, when new, of $3,247,577,000. The cost of repairs charged to I. C. C. Account 314 has averaged $357,550,000 per year for the 13-year period ended December 31, 1932.

Once each 9.08 years the amount expended for freight-car repairs was equal to the first cost of all the cars when new. The average age of freight cars on inventory date was 15.6 years; therefore, the amount spent for repairs so far during their life is equal to 1.71 times their first cost when new. At this rate the average annual cost for repairs to the average car is 11 per cent of the first cost.

Shop Machinery Repairs

The cost of repairs to shop machinery charged to I. C. C. Account 302 for the 12-year period ended December 31, 1931, averaged $23,700,000 per year. This amount is equal to 7.4 per cent of the first cost of all machinery when new. Since the average age of all machinery was 21.8 years, the cost of repairs during that period has been 1.61 times the first cost. Once each 13.5 years the amount spent for repairs was equal to their first cost.

A survey of several industrial establishments indicated that the combined average age of their machinery was between 8 and 9 years, while the cost of repairs was only 1.2 per cent of its first cost per year.

Under a general policy of renewals of machine tools on all railroads, so planned that the average age would not exceed about 7½ years, instead of 21.8 years, it is reasonable to expect that the cost for machinery repairs would not exceed the 1.2 per cent shown in private plants. On this basis the cost of machinery repairs would amount to only $3,846,000—a reduction of $19,854,000 below the present average cost of machinery repairs.

The saving of this amount for 14 years, the reduced average age, would amount to $277,956,000, which is about 87 per cent of an amount sufficient to replace all existing shop machinery.

Unserviceable Equipment

Unserviceable equipment, regardless of the cause, is a liability constituting one of the major problems in connection with maintenance.

According to recent reports of the Association of American Railroads there are 22.3 per cent of all locomotives requiring repairs and 15.2 per cent of all freight cars in bad order.

Experience has demonstrated that it is entirely feasible to maintain equipment with not more than 14 per cent bad-order locomotives and 4 per cent bad-order freight cars. On this basis there are 4,515 excess bad-order locomotives, representing an idle investment of approximately $150,810,000. The excess number of bad-order freight-cars is 219,167, representing an idle investment of $349,790,000.

These two lots of equipment represent a total idle investment of $500,600,000. The equipment that is in service must earn in addition to its own share a sufficient amount to pay fixed charges on this idle equipment which is unfit to operate until repaired.

There is little doubt that much of this excess bad-order equipment is of obsolete design and in such physical condition that it cannot and should not be restored to service.

Any general improvement in shop facilities should, of

course, take this and other pertinent facts into consideration to avoid any possibility of over-building new repair facilities.

Cost Accounting

Unfortunately, the Classification of Operating Revenues and Expenses of Steam Roads, as prescribed by the Interstate Commerce Commission in 1914, is just what its title indicates—a classification—and does not contemplate cost accounting in the sense of combining the cost of the different repair functions with physical condition or performance by which the relative effectiveness of different practices may be determined.

Management

In the absence of definite facts as to the relative cost of different methods of operation and standards of equipment design and maintenance there is presented to the management a difficult problem which must be solved very quickly if the cost of railway operation is to be reduced to meet competition from other forms of transport.

It is difficult to conceive of any greater service that could be rendered by the engineering profession than to point the way toward more effective organization and methods which will assist the management to meet more effectively the changed conditions in the transportation industry.

At the present time there are more than 150 Class I railroads, each with many different ideas as to just what constitutes proper organization.

The number of miles of satisfactory service performed by locomotives in a given period between applications of heavy repairs is the generally accepted measure of locomotive condition and is extensively used to determine repair requirements.

It would be difficult to explain the wide differences contained in replies to Questionnaire CP-2A sent out, last year, by the Federal Co-ordinator of Transportation. The number of miles per locomotive, average for an entire railroad, between general repairs varied from 28,800 minimum to 490,500 maximum, a ratio of change as 1 is to 17.

One of the most valuable lessons that can be learned from a study of the military form of organization is the benefits that will result from clearly defined channels of delegated authority and responsibility, eliminating all overlapping of authority with its consequent loss of efficiency and duplication of effort.

There are available numerous examples in railway management of the benefits resulting from correct organization which, if adopted by all carriers, would result in vast savings.

More than 90 per cent of the total cost of railway operation is accounted for by the three principal functions of operation which are maintenance of way, maintenance of equipment and conducting transportation. These three functions are so closely associated that either high or low standards of maintenance in either way or equtpment are reflected directly in the cost of the other function.

Conclusion

1—There can be no great increase in the spread between income and expense until the management as a whole is able to recognize the superior results accomplished by outstanding methods and facilities and can arrange its organization in such a manner that the entire industry may profit therefrom.

2—Economical maintenance of equipment, continuing over long periods of time, can be attained only by adopting a consistent policy of management, beginning with the careful design of equipment in every way suitable for the conditions under which it must operate. Management must then provide suitable repair-shop facilities equipped with the best machinery obtainable, together with a personnel properly organized and intelligently directed so that the service life of equipment may be restored currently as required by the traffic handled.

3—Rapid changes of major proportions in the demand for improved transportation, particularly with respect to speed, brought about by the competition of other forms of transport, have already rendered obsolete and uneconomical much equipment which heretofore has been considered "good enough" for a long time to come.

4—About one-third of the cost of a modern railroad shop is represented by the machine-tool equipment, but only 10 to 15 per cent of the total man-hours are required to operate this equipment, provided efficient arrangements are made as to space, lifting facilities and material-handling equipment to make possible continuous operation.

5—The logical procedure would be to establish appropriate means by which the following results could be accomplished:

a—Standard designs of equipment.

b—Definite objectives in the matter of service rendered by equipment, its physical condition and cost of maintenance.

c—Standardization of repair facilities, including machinery and equipment.

d—Uniformity of shop practices, developed by studying the best methods and making them available to all railroads.

e—Uniformity in cost accounting.

f—Elimination of costly and unnecessary manufacturing operations in competition with private industry.

g—Intensive utilization of both locomotives and cars in order to reduce the number of units to a minimum.

h—Determination of the most economical service life for all kinds of equipment, establishment of a uniform policy of renewals, based on economic facts rather than upon personal opinion.

References

For the benefit of those who wish to pursue this subject further, there is listed below a number of references which may be helpful.

1—American Railway Engineering Association—Bulletin 343, January, 1932, describing the general principles involved in locomotive-shop design, as used by the author, with particular reference to the Chesapeake & Ohio shops at Huntington, W. Va.

2—Railway Mechanical Engineer, May and June, 1931—Chesapeake & Ohio locomotive shop.

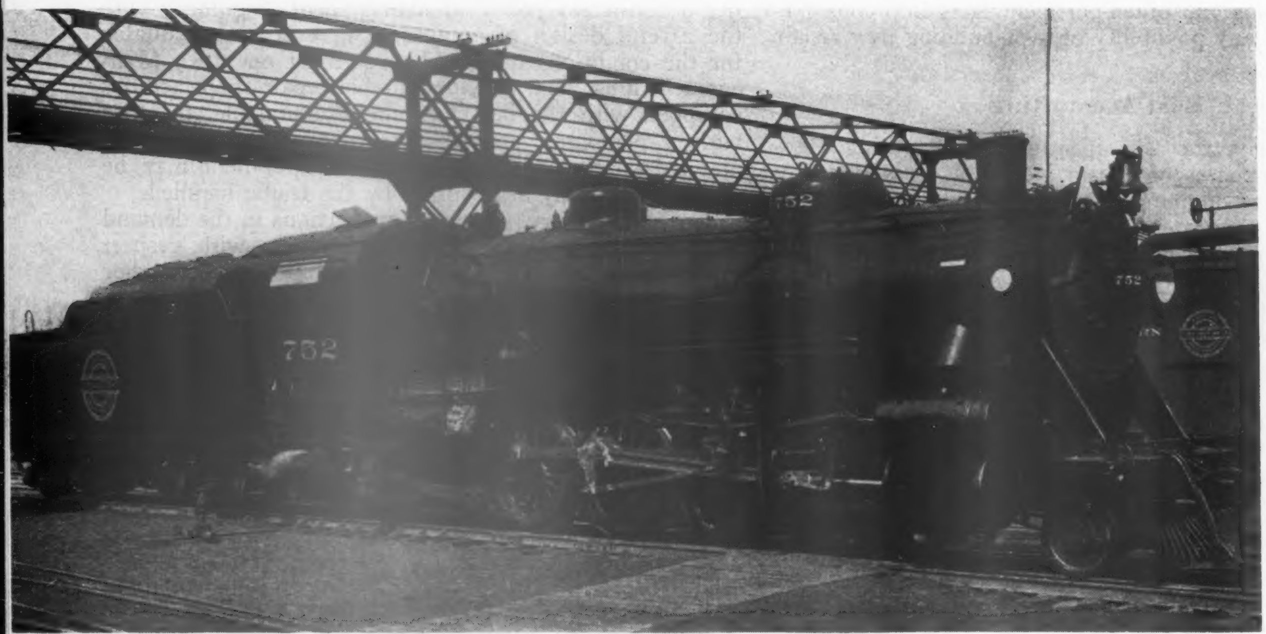
3—Railway Age, August 29, 1931—Chesapeake & Ohio car shop.

4—The Boiler Maker, June, 1927—Chesapeake & Ohio boiler shop.

5—Railway Mechanical Engineer, December, 1927—Chesapeake & Ohio enginehouse.

6—American Machinist, August 21, 1930—Equipping a railroad shop for continuous production.

YOU NEVER CAN TELL.—Since the days when the Indians were attacking trains in the West, there has been little or no use for expert riflemen in railroad work. It would have seemed, in fact, that the services of such a person would never be needed. Still, in railroading, nothing is sure except taxes, and, recently, a rifleman was required in railroad work. A smokestack on an enginehouse was scheduled to be taken down and replaced, but was found to be so corroded near the top as to involve a considerable hazard to the men employed in dismantling it. Nothing daunted, the intrepid foreman got out his trusty rifle, and from a safe distance and with unerring aim, drilled a ring of bullet holes around the stack near the top until the corroded portion came crashing down, with no one in the vicinity to be injured by its fall. After that, it was a simple and quite safe matter to dismantle the rest of the stack.



C.G.W. Mikado locomotive just outside Oelwein shops

Locomotive Maintenance Facilities at Oelwein Improved

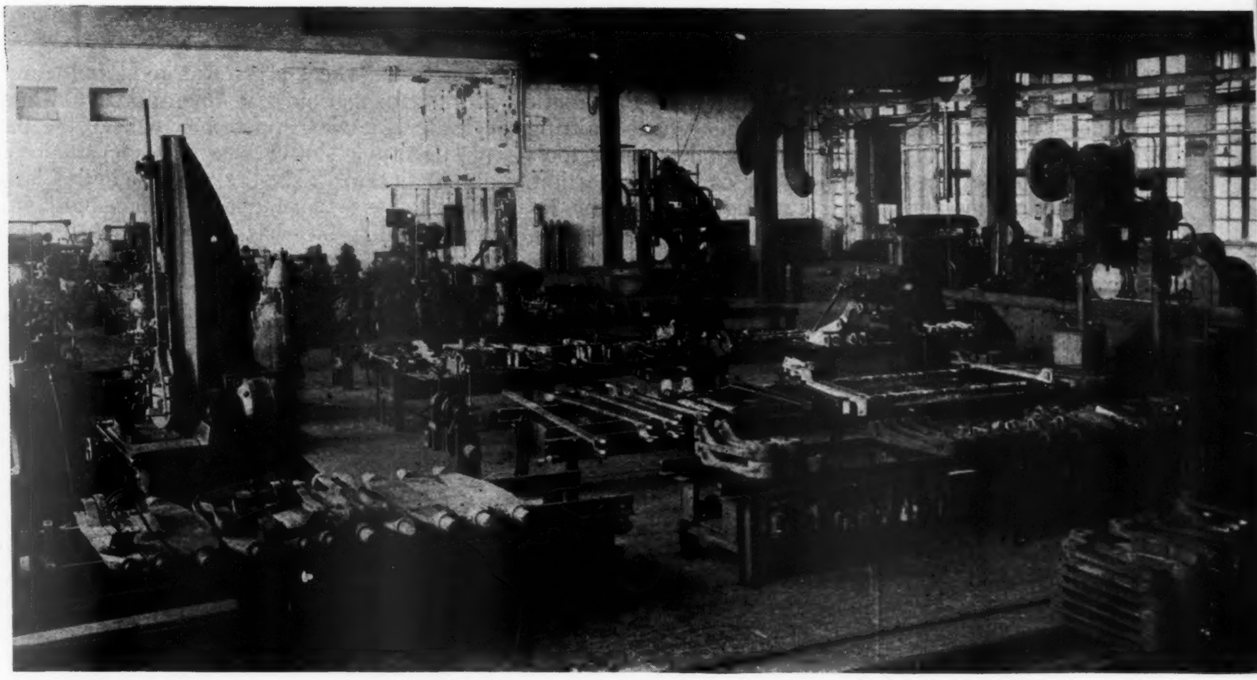
New machinery and equipment installed in C. G. W. backshop and enginehouse—Many obsolete shop tools retired

DURING the past four years, the Chicago Great Western has initiated and carried to practical completion a program of improvement of its locomotive maintenance facilities at Oelwein, Iowa, which places this road in an admirable position to keep motive power in good working condition at minimum expense. When the 36 2-10-4 freight locomotives were received on the Great Western in 1930, it was found that the facilities at the Oelwein locomotive shops were entirely inadequate, as the pits in the shop were too short; the transfer table was not strong enough; the hoist for lifting locomotives while unwheeling did not have sufficient capacity; and the machine-tool equipment was, to a great extent, obsolete.

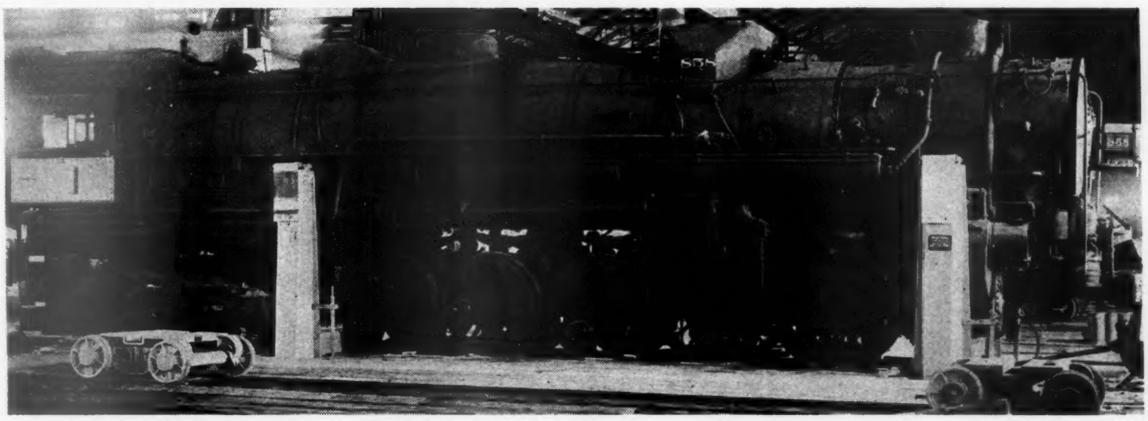
To relieve this condition temporarily, it was decided to install enough new facilities and machinery at the Oelwein enginehouse to permit giving light classified repairs to the 2-10-4 type locomotives and keep them in service until such time as they were due for general overhauling and heavy boiler repairs. With this end in view, a Whiting 50-ton electric drop table, with pit connection to five tracks, was installed early in 1931, making it possible to remove or apply a pair of driving wheels in about six minutes, as compared with 20 minutes formerly required. Twenty-one modern machine tools were also installed, including a Niles 90-in. heavy-duty driving-wheel lathe, Micro portable crank-pin grinder, a Bullard 24-in. vertical turret lathe, two new Duff-Norton 100-ton jacks, a Baker electric crane truck, three jib cranes, etc., as shown in one of the tables.

Subsequently, authority was granted to remodel completely the Oelwein locomotive shop, and this work was started in July, 1933. A total of 27 new machines was installed, as shown in one of the tables. The Whiting 250-ton, four-jack, locomotive hoist was located in a pit which extends into the old Mallet house, and it is now possible to remove all of the driving wheels, engine truck, trailer truck and booster wheels from a 2-10-4 type engine in about 50 min., replacing them in about 1 hr. 45 min. Formerly, a locomotive had to be sent to the enginehouse to have the wheels removed, one pair at a time, in a drop pit, time required 25 minutes per pair.

Four of the pits in the backshop were completely rebuilt and extended back underneath the balcony, in order to give them sufficient length to accommodate the new locomotives. The unique feature of these pits is the



General view of new machine equipment and the material racks which help in keeping floors clean



A 2-10-4 type locomotive on the Whiting 250-ton electric hoists at Oelwein shops

fact that they do not extend to the back end of the locomotive, the portion of the floor underneath the firebox being built up to the track level. As the trailer truck previously has been removed on the locomotive hoist, it is possible to work on the firebox while standing on the floor and a pit is not needed at this end.

Practically all of the old wooden plank floor was removed and a concrete floor now extends over most of the shop, thus greatly facilitating the movement of material by means of trucks and tractors. Another feature is the provision of suitable work benches, racks and platforms so that no locomotive parts or materials are permitted to be on the floor at any time. This contributes both to neatness and to shop efficiency.

In laying out the shop, it was found that there was not sufficient floor space on the machine side to take care of all of the machine work and, for this reason, it was necessary to fill in several erecting pits and use this portion of the shop for machine tools. Five pits in the south end of the machine shop were filled in and covered with a concrete floor, this portion of the shop being now utilized for the repair of air-brake equipment, valve gears, injectors, lubricators, power-reverse gears, and other special appliances.

In this department, there have been installed a Landis piston-rod grinding machine, a Diamond guide-bar grinder, a Sundstrand link grinder, a No. 5 Cincinnati plane miller, a 24-in. Monarch lathe, and several other smaller tools, all of them being of the latest design intended for accurate, rapid work.

The tool-room arrangement and equipment were completely revised, several old machines being retired and replaced by modern equipment, including a Monarch 18-inch engine lathe, a Cincinnati No. 2 cutter grinder and a Cincinnati No. 3 universal milling machine. In addition, over 700 carbon-steel drills, reamers, wrenches, pneumatic tools, etc., were scrapped, and replaced by modern equipment. These small tools, kept on modern steel tool racks and shelving, are now issued on checks by a competent tool-room attendant. When tools are

returned to the tool-room, their condition is carefully checked and repairs made when necessary. Pneumatic tools used in the shop are left on the job at quitting time, but a night tool-room attendant takes these tools back to the tool-room each night for careful inspection, lubrication and testing, then returning them to the respective shop departments where they are available in good condition ready for operation just as soon as the shop whistle blows in the morning.

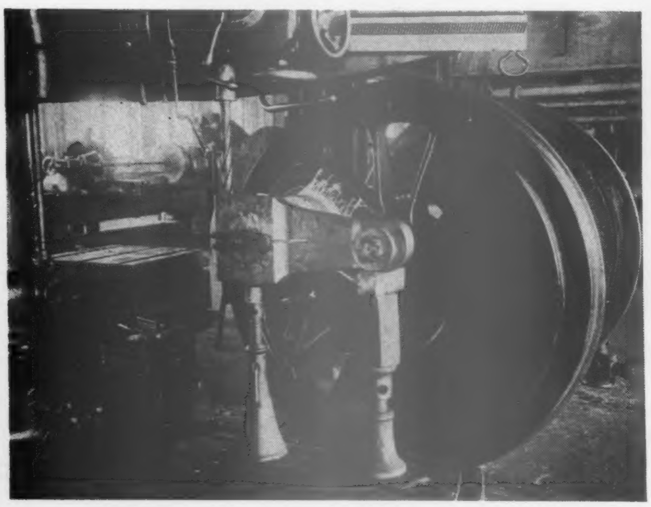
135 Old Machines Retired

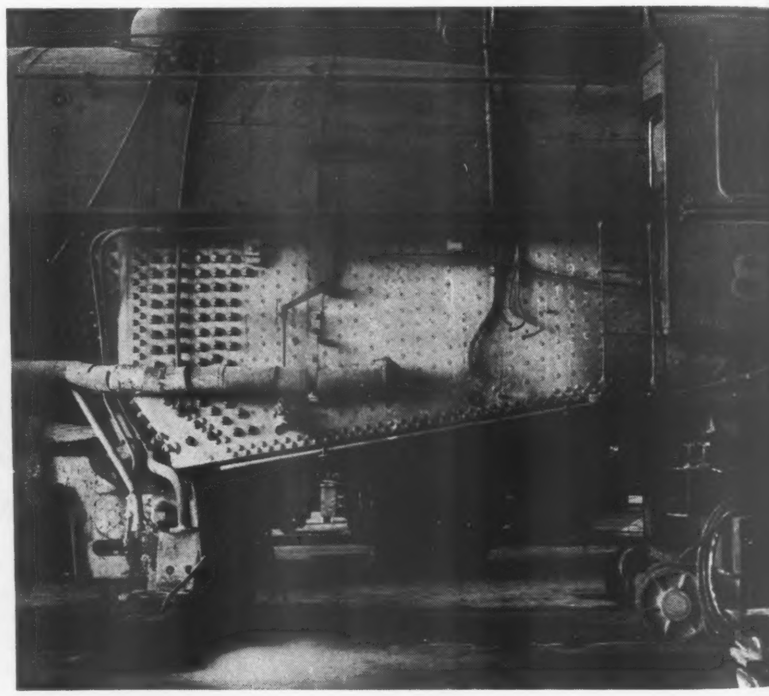
In deciding what machines were to be replaced in this modernization program, the production needs of the shop were given first consideration. A total of 122 machines, most of which were obsolete, belt-driven tools, were retired in the locomotive shop and 13 old machines in the enginehouse. So great has been the improvement in productive capacity of modern machine tools that it was not necessary to replace all of the old tools. As a matter of fact, 27 new machines were installed in the locomotive shops and 21 in the enginehouse.

An examination of a partial list of 20 of the old tools retired shows how inadequate they were for modern requirements. One lathe was 48 years old and one milling machine 22 years old, the average age of the 20 machines being 31½ years. Their condition was in many instances deplorable both as regards low productive capacity, inaccuracy and high maintenance cost. Referring to individual machines, the first is a radial drill with a broken and patched bed. The machine lacked the power and accuracy needed for modern drilling operation. The quartering machine, shown next, was inaccurate on account of worn ways, and had to be checked constantly. It also was inadequate in size for refinishing large modern crank pins. The engine lathes had worn gears and feed screws, ways worn low in the middle and lacked power. The planers were generally worn out, including the bedways and gears, line shafts and counter shafts. The 96-in. wheel press was too small for modern 13-in. axles and also slow in operation. On account of worn cylinders, it was impossible to keep the packing tight.

The crank slotter was obsolete and costly to operate and maintain. The next two engine lathes, shown in the list, were worn out and inadequate in power. The boring-mill table was patched and the machine totally incapable of supporting modern cutting feeds and speeds. The No. 4 milling machine was worn out by continual use and overloading on heavy slab-milling operations. The two grinding machines were incapable of anything like accurate grinding operations. The No. 3 universal milling machine was both inadequate in capacity and inaccurate, due to heavy service. The sensitive drill was worn out and anything but sensitive in operation. The turret lathe, used for manufacturing pump rings, had a three-jaw universal chuck which could not hold the work. The machine was badly worn on the ways and the carriage feed screws. Forty-five minutes were required to machine a crosshead bolt which frequently had to be scrapped immediately afterwards on account of being out of round, tapered or thread-stripped. The wheel lathe heads were out of line and the machine was continually breaking down. In spite of constant repair work, it could hardly be kept in operation and, under the best of conditions, its production was two pair of driving wheels in eight hours.

Driving-wheel crank-arm set up for drilling

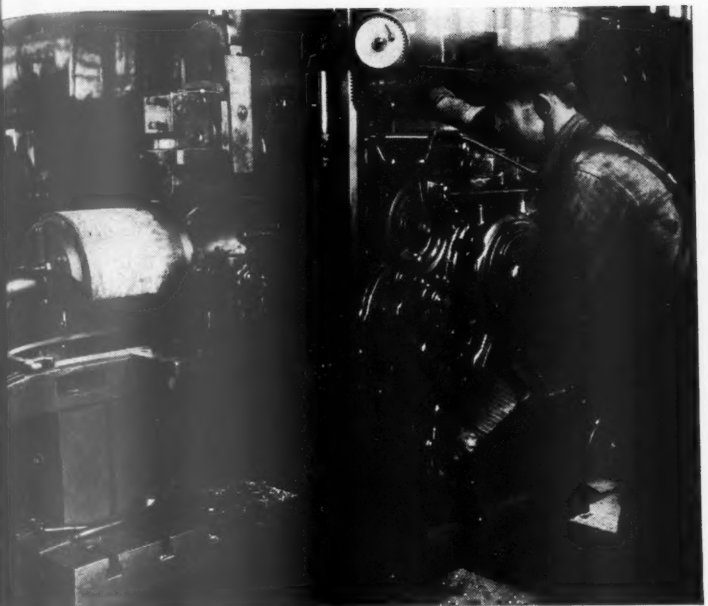




Pits filled in under fireboxes are a boon to the boilermaker

New Machines in the Locomotive Shops

The 27 new machines and tools installed at the Oelwein locomotive shops included six Cullman motor-drive applications to replace belt drives from overhead line and counter shafts. The new lathe in the tool-room is very helpful for doing accurate work and has saved 25 per cent of the cost of repairing tools and machinery. The No. 3 Universal Cincinnati miller is said to have paid for itself in the last six months on general tool-room work. The Cincinnati grinder has permitted



The Morton draw-cut shaper machining a crown brass

keeping all reamers ground accurately and in first-class condition, with marked saving of time and labor in the erecting shop.

The Monarch 24-in. lathe was installed in the cross-head and piston gang, cutting the time of turning piston rods and fittings from 6 hr. 20 min. to 3 hr. 30 min. Due to greater power and a heavier machine, it can take heavier cuts at greater speed. In the wheel department, a Monarch 36-in. lathe is used for turning axles, crank pins and steel rod bushings, cutting the time for a 9-in. by 12-in. axle from 8 hr. to 4 hr. 45 min.

The Morton draw-cut shaper in the driving box gang is used for machining driving-box shoes and wedges and steel boxes, also for fitting crown brasses to driving boxes. This work was formerly done on a boring mill, a 25-in. planer and a 24-in. crank shaper. Fitting the crown brass alone formerly took 1 hr. 15 min., this work being done on the new machine in 34 min. in the case of a brass for a 9-in. by 12-in. journal.

In the wheel gang, the new 800-ton wheel press can now press all wheels on and off 15-in. axles. It also handles booster crank arms and wheels which could not be handled in the old press. A quick-acting hydraulic pump cuts the press time approximately 50 per cent. With the quartering machine in the wheel gang, wheels can now be quartered on all classes of power. Driving wheels and pins are thus reconditioned without pressing them out and pressing back in again. The new wheel lathe has a productive capacity to turn the tires on a pair of driving wheels in 50 min., floor to floor.

The link grinder used in the link gang does effective work in grinding the radii on link blocks and links. It replaces old shop-made equipment which was inaccurate and time-consuming. With the new machine, it is stated that a 70-per cent better job is done in 50-per cent shorter time.

The Diamond 30-in. slab grinder is used for grinding guides, link plates, engine-truck jaws, binders and many other parts. This work was formerly done on a planer and slab miller, the parts afterwards being polished and finished by hand. The time saved is approximately 80 per cent, using the new machine, the finishing operation being done in 25 min., floor to floor, on the grinder with a $\frac{1}{32}$-in. cut. The Landis grinder at the piston job is used for grinding piston-rod valve stems, axle journals,

Partial view of the quartering machine and the driving-wheel lathe

air-pump pistons, stoker pistons, booster pistons and valve rods. This work, on a 5-in. piston rod for example, turned, filed and polished, formerly took at least 1 hr. 20 min. and is now handled in 28 min.

The Warner & Swasey turret lathe is used in making studs, straight-fit bolts and crosshead gib bolts, this work being done on the new machine very accurately and at a high production rate. The old screw machine formerly was kept busy on this work and required the partial time of three other machines to help keep it up. The Warner & Swasey machine now handles all of this work by itself. Crosshead gib bolts, formerly made in 30 min. per bolt, are now finished in 4 min. each, after the machine is set up. The Cincinnati plain miller is used in making new link-motion work, milling piston rods and crosshead eyes and valve-bushing port holes. It permits cutting the time approximately 40 per cent on any one part of the motion work, including the milling of valve bushings.

The rod-bushing press replaces an old shop-made 50-ton press which was too light and too small to meet the requirements. The new 200-ton press will handle all brasses and heavy bushing work in 60 per cent less time, being notable for its high power and high speed operations.

The 100-ton rod press in the link and motion gang is used for the application and removal of bushings. It also replaces a shop-made press which was a slow, belt-driven machine of only 25 tons capacity, unable to handle large pins and bushings. The modern, quick-acting press saves approximately 60 per cent in the time for this operation.

The 20-in. Monarch lathe is a general purpose tool used in the machine shop, replacing an old Nile 20-in. belt-driven inaccurate and slow machine. Where two of these old lathes were formerly needed, the new lathe takes care of the work, saving about 50 per cent of time.

The 15-in. Bardons & Oliver brass lathe replaces an old lathe which could not do accurate work and necessitated doing brass work on a standard engine lathe. The new machine takes care of all cab work, air-pump packing and brass fittings, and saves about 20 per cent in time. In the link gang, two sensitive drill presses save 50 per cent on small drilling operations.

The six Cullman drives are applied to four Shoemaker-Boyes lathes and to two bolt cutters, providing individual motor drives and eliminating belts, pulleys, counter shafts, etc. The use of these drives has enabled machines to be placed wherever most convenient for the ordinary handling of the work and has saved roughly 25 per cent in labor.

Uniform Force—General Shop Operation

Since installing the new shop equipment at Oelwein shops and revising the organization, it has been possible to maintain a fairly uniform force. Sixty-five men have been used in the locomotive department 40 hours a week

Twenty Typical Machine Tools Retired at Oelwein Shops

Machine	Manufacturer	Date purchased	Age
Radial drill press	Niles Tool Works Company	1902	33
Quartering machine	Niles-Bement-Pond	1898	36
18-in. lathe	Lodge & Shipley	1901	34
20-in. by 10-ft. engine lathe	Fitchburg Machine Works	1887	48
25-in. planer	Niles Tool Works Company	1895	40
32-metal planer	Cincinnati Planer Company	1900	35
32-in. shaper	Morton Manufacturing Company	1913	22
96-in. 600-ton wheel press	Niles-Bement-Pond	1910	25
18-in. crank slotter	Betts Machine Company	1903	32
24-in. engine lathe	Schumacher & Boye	1910	25
30-in. engine lathe	Niles Tool Works Company	1898	36
36-in. vertical boring mill	Niles Tool Works Company	1902	33
No. 4 milling machine	R. K. LeBlond Machine Company	1913	22
Yankee grinder	Wilmarth & Morman	1910	25
Universal grinder	Brown & Sharpe	1904	31
22-in. lathe	Lodge & Shipley	1905	30
No. 3 universal milling machine	Hendey Machine Company	1902	33
36-in. vertical drill press	Niles Tool Works Company	1899	36
Turret lathe	Gisholt Machine Company	1905	30
Wheel lathe	Niles-Bement-Pond	1910	25

Average age—31½ years.

Machines Added at Oelwein Shops Since July 1, 1933

No. of machines	Type	Manufacturer
1	18-in. by 28-ft. lathe, second-hand	Monarch Machine Tool Company
1	24-in. by 14-ft. lathe, second-hand	Monarch Machine Tool Company
1	36-in. by 16-ft. lathe, second-hand	Monarch Machine Tool Company
1	Draw-cut shaper, 36-in. stroke	Morton Manufacturing Company
1	800-ton, 96-in. wheel press	R. D. Wood & Co.
1	90-in. quartering machine, second-hand	Niles Tool Works Company
1	90-in. wheel lathe, second-hand	Niles Tool Works Company
1	Link grinder	Sundstrand Machine Tool Company
1	250-ton hoist	Whiting Corporation
1	30-in. slab grinder	Diamond Machine Company
1	20-in. by 96-in. gap grinder	Landis Machine Company, Inc.
1	Turret lathe	Warner & Swasey Co.
1	No. 2 cutter grinder	Cincinnati Grinders, Inc.
1	No. 3 universal miller	Cincinnati Milling Machine Company
1	No. 5 plain miller	Cincinnati Milling Machine Company
1	200-ton rod bushing press	R. D. Wood & Co.
1	100-ton rod bushing press	R. D. Wood & Co.
1	20-in. by 48-in. lathe	Monarch Machine Tool Company
1	15-in. brass lathe	Bardons & Oliver
2	Sensitive drill presses	———
6	Electric motor lathe drives	Cullman Wheel Company

Machines Installed at Oelwein Enginehouse Since May 1, 1931

No. of machines	Type	Manufacturer
1	50-ton electric drop table	Whiting Corporation
1	90-in. wheel lathe	Niles Tool Works Company
2	Double-end grinders	Ransom Grinding Machine Company
1	4-in. radial drill	Dreses Machine Tool Company
1	Rockford drill	Rockford Machine Tool Company
1	24-in. vertical turret lathe	Bullard Company
1	36-in. crank shaper	Ohio Machine Tool Company
1	100-ton bushing press	Hydraulic Press Manufacturing Company
1	20-in. engine lathe	Sidney Machine Tool Company
1	Portable crank pin grinder	Micro Machine Company
1	36-in. by 16-ft. engine lathe	Betts-Bridgeford Company
1	2-in. bolt threader	Landis Machine Company, Inc.
2	Pit grinders	Ransom Grinding Machine Company
2	100-ton jacks	Duff-Norton Manufacturing Company
1	Electric crane truck	Baker-Raulang Company
1	18-ft. jib crane, 6-ton hoist	———
1	13-ft. jib crane, 2-ton hoist	———
1	18-ft. jib crane, 1-ton hoist	———

The Diamond guide-bar grinder is used on many surface-grinding operations

The rod-bench is served by monorail and chain falls—Note the break in bench rails to save time in getting around

and the output has averaged 3½ Class-3 repairs to the 2-10-4 type locomotives per month. The improved shop condition has enabled better work to be turned out in about one-third less time than could have been done with the old equipment. By making this saving the railroad has been able to provide more steady and uniform shop employment. Under the present scale of operation, mileage is being put back into Great Western power faster than it is being run out.

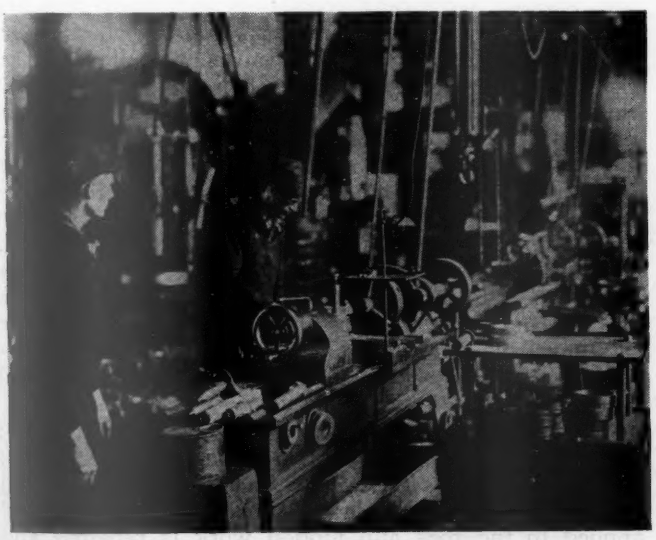
Referring to the drawing, the general method of operating the Oelwein locomotive repair shop is as follows: Locomotives are received on Pits 5 to 14, where the rods, brake rigging and piping are stripped. The locomotives are then taken to Pit 22 over the Whiting hoist, where the binders are dropped and the locomotives unwheeled; all wheels are pulled out with a cable in one operation. Dolly trucks are applied and the locomotive is moved back to the erecting pit, via the transfer table.

Wheels are sent to the wheel department and stripped after first being cleaned. Driving boxes are trucked to the cleaning vat and then to the driving box department where new brasses are applied. All driving boxes are built up to standard size. The box faces are planed on a 36-in. Morton draw-cut shaper, which also finishes the crown brasses.

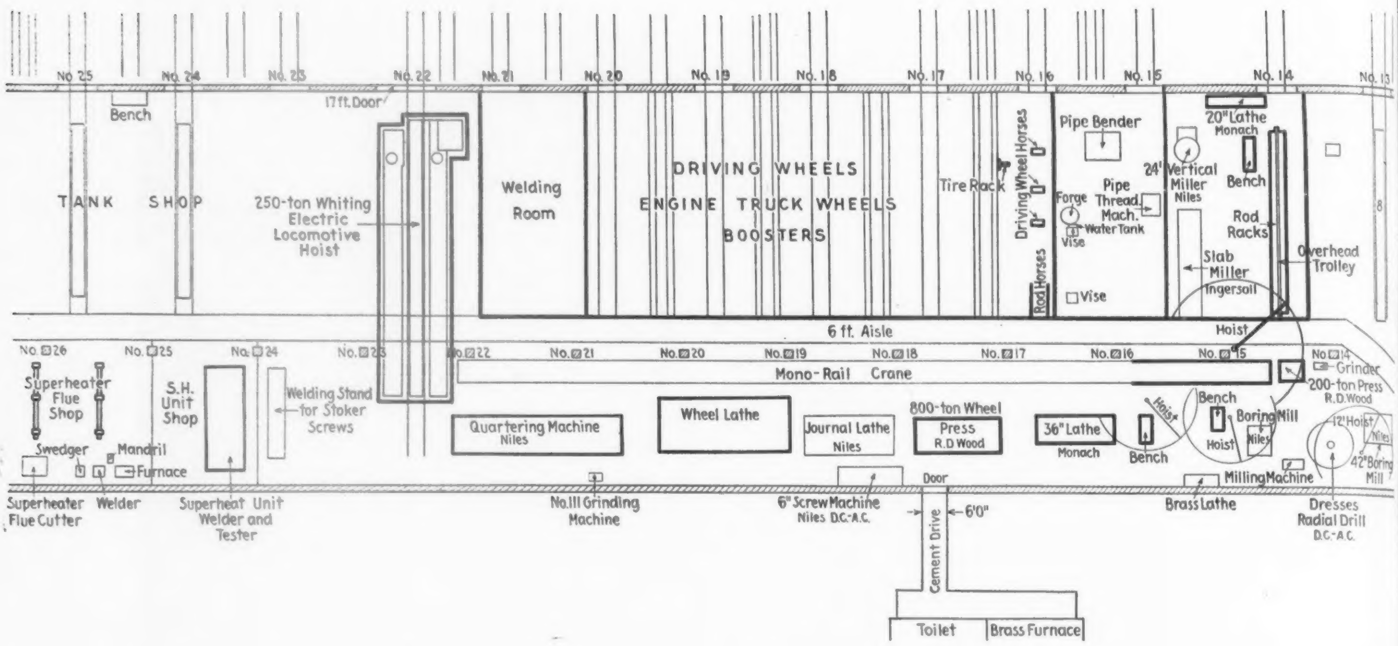
Rods are sent to the cleaning department and returned to the rod bench for testing and finishing. In this connection, the special rail-type rod benches keep all rods off the floor, support them at a convenient height for working on them and an overhead traveling pneumatic hoist saves labor in handling. Piston valves and crossheads are cleaned and sent to the proper departments for necessary repair work on these parts. Air-brake parts are sent to the air-brake department which has its own cleaning vats. All air-brake valves are repaired and tested at this point.

Flues are removed from the boiler and loaded on flue trucks, each of which carries a complete set to the cleaner, from which the flues are moved to the flue shop for safe-ending, testing and cutting off. Superheater units are removed and taken to the superheater-unit position. In cases where extensive boiler work necessitates, the boilers are cut free from the frames and cylinders and moved by a 60-ton traveling crane into the boiler shop. A 15-ton messenger crane is available for lighter movements underneath the main crane. Booster and stoker work is done in a department adjacent to the unwheeling pit. The stoker screws are built up with a combination of acetylene and electric welding to the original diameter and thickness. Acetylene is used in tack-welding and forming the new steel spiral strip applied to the outside edge of the screw and electric welding is used for completing the welding operation. This work is done in an engine lathe between centers with a gage to indicate the proper height and flight of each web.

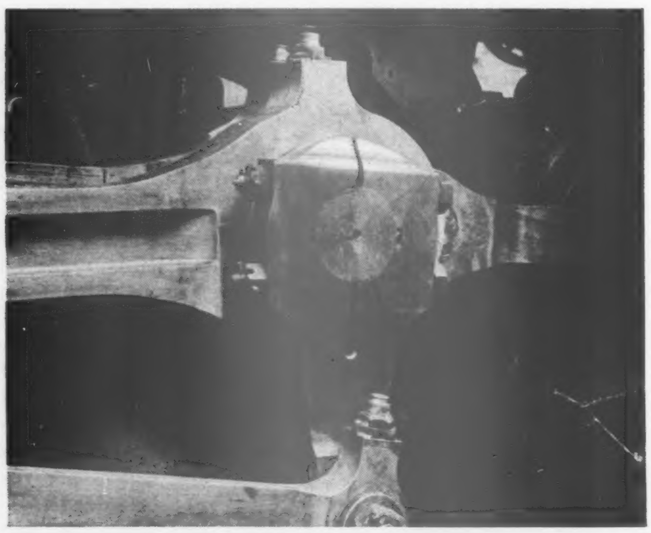
The eccentric-crank repairs at Oelwein are unusual in that the main driving wheels and cranks are assembled,



Typical old belt-driven machines replaced



Floor plan showing the general arrangement of various facilities at Oelwein



The crank-arm application used on the C.G.W.

complete, in the wheel department. With the wheels on rollers, the wheels are revolved and the arms set to give the proper throw, using a tram from the center of the crank pin to an upright marking plate. A clamp is used to hold the eccentric in the proper position. The wheels are then sent to the radial drill as shown in one of the illustrations. This drill is equipped with floor rails at right angles to the drill press table. The crank arm bolt holes are drilled and reamed. The arm is removed and the blind keyway drilled, using first a standard and then a flat drill. The keyway is chipped. When assembled, the crank cannot move.

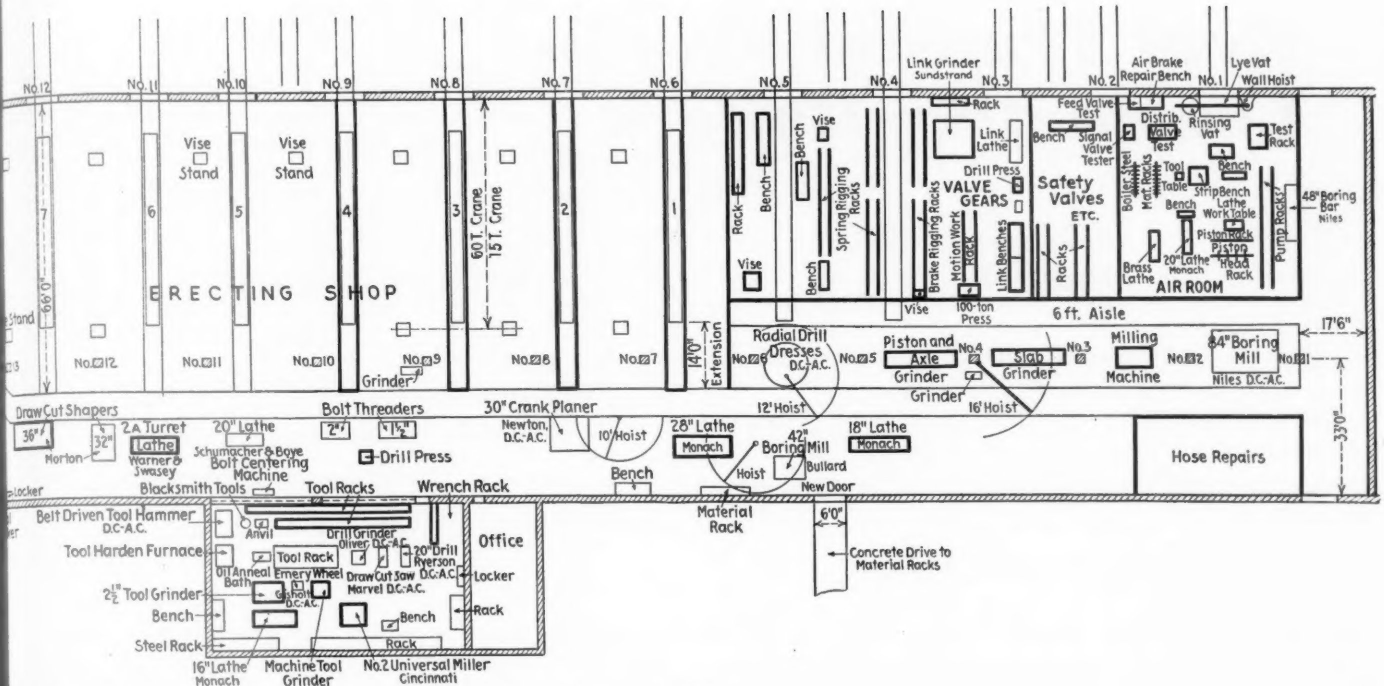
In valve setting, all points on the valve-motion work are checked and brought to standard length. The height of the tumbling shaft and center to center of the trunion bushings are also checked and tumbling shaft arms are set at right angles to each other. All necessary valve changes are made on the valve spool and the eccentric rod only. All parts are assembled and the engine run over and hooked up to 60 per cent of travel by moving the locomotive with a transfer cable. Sometimes no changes are required and on other occasions slight alterations only may be needed in the eccentric position, or the spool.

A "Three-Day" Drop Pit Job

In order to maintain the new locomotives in the class of service for which they are used on the Chicago Great Western it has been found necessary to recondition the power about every three or four months. By means of a "three-day" drop pit job, which is usually performed midway between classified repairs, the power is reconditioned so as to give practically double the mileage between heavy general repairs.

In this operation, a 2-10-4 type locomotive is placed over the drop pit at 8:00 a. m. the first day. All rods are removed and checked for wear, bushings are checked and renewed, wrist pins, crossheads and piston rods are all whitened and tested for cracks and are checked for wear and needed repairs. The valves are pulled, pistons checked for size of cylinder, for loose rivets in the bull rings and for looseness on the fit. Driving boxes are removed, brasses checked, and renewed when necessary on account of looseness or improper fit, and hub liners knocked off driving boxes and made ready to be re-poured for taking up the lateral. Brass is poured on driving boxes and machined to take up excessive lateral. Driving wheels are checked for journals needing to be trued up; crank pins are renewed or trued up; tires are checked and reset, if necessary, and wheels sent to the shop to have tires turned. Crosshead shoes are re-babbited; bolts checked and renewed and holes reamed if necessary.

On the second day, the spring rigging is overhauled; shoes and wedges are lined and planed if necessary; driving-box brasses are applied and the boxes machined and fitted to the journals; rod bushings are made and applied to the rods and motion work is repaired and made ready for application. Crossheads are put up, gib

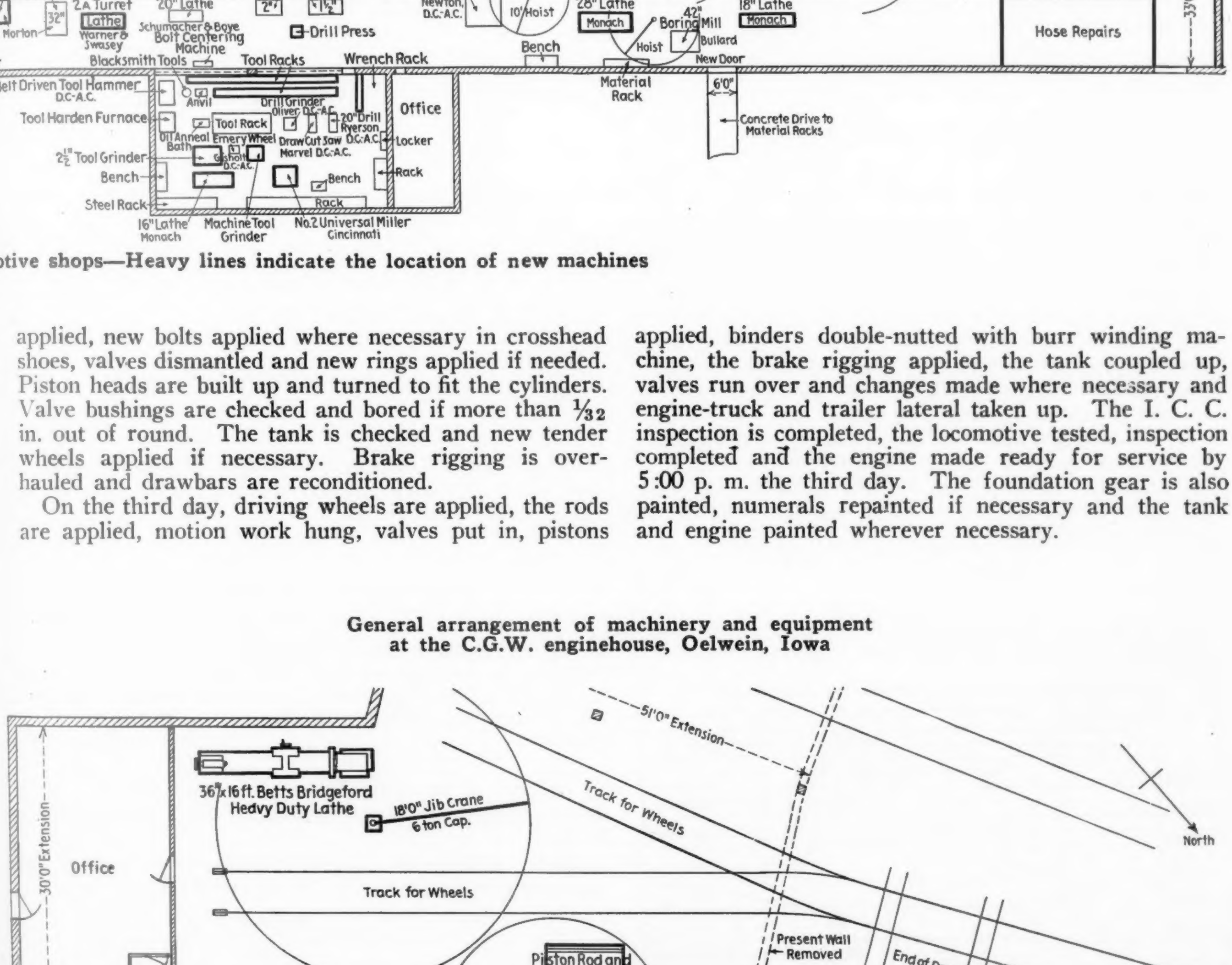


comotive shops—Heavy lines indicate the location of new machines

applied, new bolts applied where necessary in crosshead shoes, valves dismantled and new rings applied if needed. Piston heads are built up and turned to fit the cylinders. Valve bushings are checked and bored if more than $\frac{1}{32}$ in. out of round. The tank is checked and new tender wheels applied if necessary. Brake rigging is overhauled and drawbars are reconditioned.

On the third day, driving wheels are applied, the rods are applied, motion work hung, valves put in, pistons applied, binders double-nutted with burr winding machine, the brake rigging applied, the tank coupled up, valves run over and changes made where necessary and engine-truck and trailer lateral taken up. The I. C. C. inspection is completed, the locomotive tested, inspection completed and the engine made ready for service by 5:00 p. m. the third day. The foundation gear is also painted, numerals repainted if necessary and the tank and engine painted wherever necessary.

General arrangement of machinery and equipment at the C.G.W. enginehouse, Oelwein, Iowa



Heat Transmission in Locomotive Boilers

Part II

By H. S. Vincent*

In the first section of this article, which appeared in the May issue of the Railway Mechanical Engineer, Mr. Vincent reviewed the Coatesville test of 1912 and subsequent locomotive laboratory tests. Available test data were tabulated and detailed explanations of these data were given.

Continuation of study as to relative value of heating surfaces in firebox, tubes and flues and in superheaters

Discussion of Tabulated Data

14—In Tables 2, 3, 7, 8, 11, 12, 16 and 17 all of the data available has been utilized. In Tables 1, 4, 5, 6, 9, 10, 13, 14, 15 and 18 certain tests were selected from the mass of data available. The only criterion followed in making this selection was the greatest possible range of energy liberation. In constructing the firebox temperature curves the data from all available tests were used rather than from the few tests selected for discussion. Fig. 3, illustrates the construction of a typical temperature curve, in which the tests used in the tabulation are indicated by enclosing circles.

15—The weight of mixed gases passing over the heating surfaces, bears a definite relation to the weight of fuel burned. This relation for the tabulated tests has been plotted in Figs. 4-4H. The equation for the gas curve is in the form;—

$$G_c = (eG - fG^2 + hG^3) \quad \ldots\ldots (8)$$

in which

G_c = weight of gas passing over heating surfaces per sfg/hr.
G = weight of dry fuel fired per sfg/hr.
e, f and h, are constants varying with design of boiler and characteristics of fuel used.

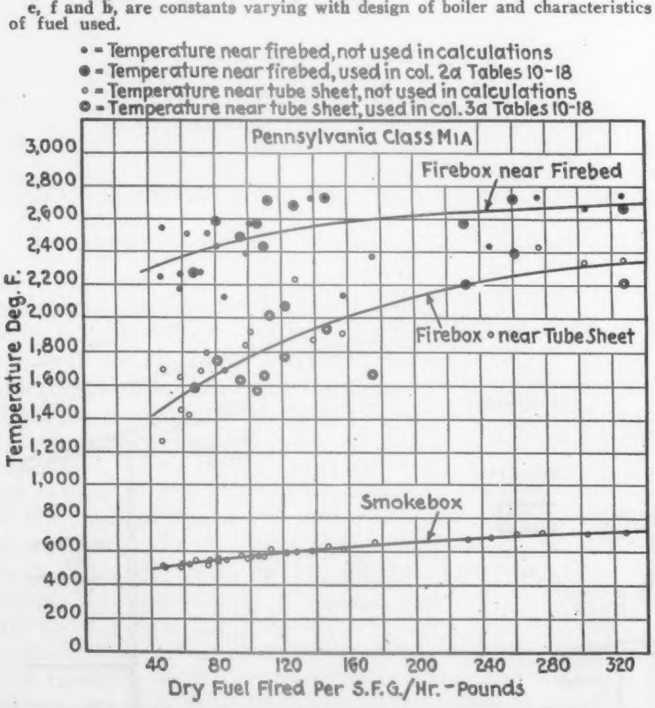


Fig. 3—Firebox and smokebox temperatures as taken in test of Pennsylvania Class M1a showing curves of mean temperatures

A typical gas curve for the Pennsylvania class M1a, is shown in Fig. 4. The equation for the curve is;—

$$G_c = 15.12G - 0.0306G^2 + 0.0000147G^3$$

The straight line relation between the weight of mixed gas per pound of coal burned and the firing rate has been demonstrated by Fry. For class M1a, the equation is;—

$$C_g = 18 - 0.014G \quad \ldots\ldots (9)$$

in which

C_g = the weight of gas per pound of coal burned.

The relation between the weight of coal burned to coal fired is shown for class M1a, in Fig. 5, by the equation;—

$$C_b = 0.84 - 0.001047G \quad \ldots\ldots (10)$$

in which

C_b = ratio of coal burned to dry coal fired.

The product of equations (9) and (10) multiplied by G equals the term on the right of equation (8).

16—Fry has shown that the total boiler efficiency, when plotted in relation to the dry fuel fired per sfg/hr., can be represented by the straight line equation;—

$$F = m - nG \quad \ldots\ldots (11)$$

in which F is the total boiler efficiency while m and n, are constants, varying with boiler design and character of fuel.

As a correlary of (11), the total evaporation of the boiler can be expressed by the equation;—

$$W = Y \times \frac{mG - nG^2}{100} \quad \ldots\ldots (12)$$

in which

W = total evaporation per hour of boiler
K = calorific value of dry fuel, B.t.u. per pound
R_o = grate area, square feet
u = B.t.u. required to produce one pound of steam from feed water
Y = KR_o/u

Equation (12), is a simplification of Fry's similar equation by omitting heating surface and grate area relations. Having the characteristics of a parabola, the evaporation curve reaches its maximum at a firing rate represented by Fry's equation;—

$$G_{w\,max.} = m/2n \quad \ldots\ldots (13)$$

in which

$G_{w\,max.}$ = firing rate per sfg/hr. at maximum evaporation

17—The component parts of the boiler, viz. firebox,

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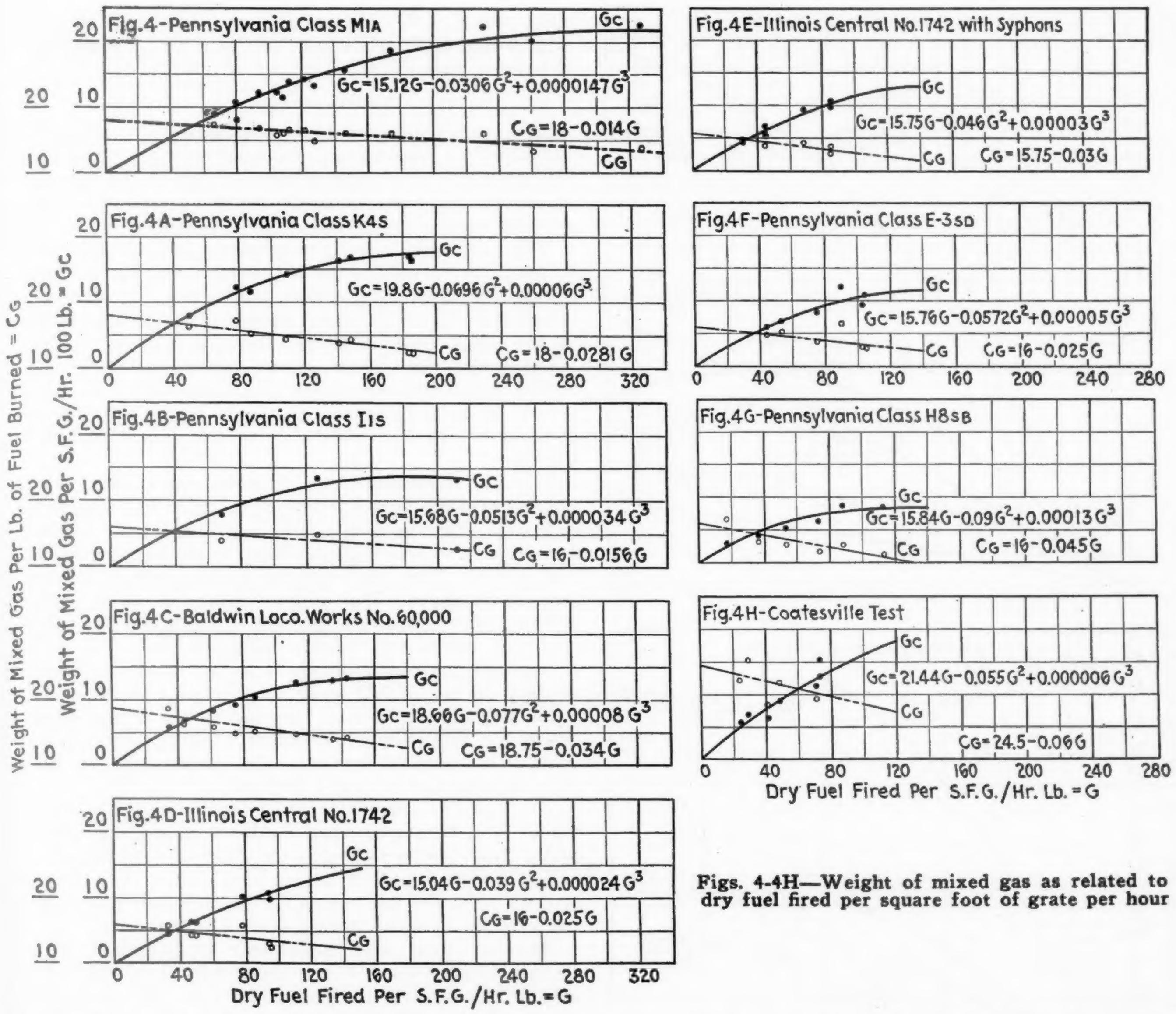


Figs. 4-4H—Weight of mixed gas as related to dry fuel fired per square foot of grate per hour

tubes and superheater, each have the same evaporative characteristics as the complete boiler. That is, their efficiency may be expressed by straight line equations having the form;—

Firebox	$F_f = m_f - n_fG$	(14)
Tubes and flues	$F_t = m_t - n_tG$	(15)
Superheater	$F_s = m_s - n_sG$	(16)

the subscript indicating the component part to which the equation refers.

In like manner, the evaporation of each component part is represented by the equations;—

Firebox $$W_f = y \times \frac{m_f - n_fG^2}{100} \quad (17)$$

Tubes and flues $$W_t = y \times \frac{m_t - n_tG^2}{100} \quad (18)$$

Superheater $$W_s = v \times \frac{m_s - n_sG^2}{100} \quad (19)$$

in which

$$y = K/u$$

In Figs. 6—6G, inclusive, the evaporation per sfg/hr. for the total boiler also for each of its component elements is shown by curves constructed in accordance with equations (12), (17), (18) and (19). The evaporative curve for the complete boiler is constructed from data representing a complete test. The evaporation curves for the component parts are based on the particular tests selected for this discussion.

18—The test of the Pennsylvania M1a, Fig. 6, is of particular interest. No other locomotive has been tested to such high capacity, it having attained a fuel rate of 327.4 lb. per sfg/hr. without reaching its evaporative

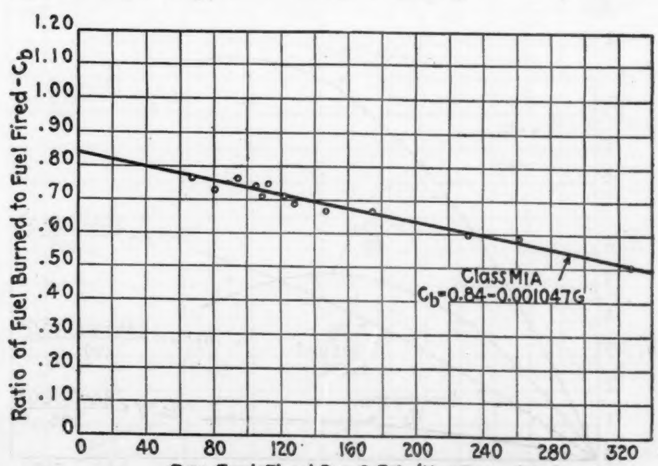
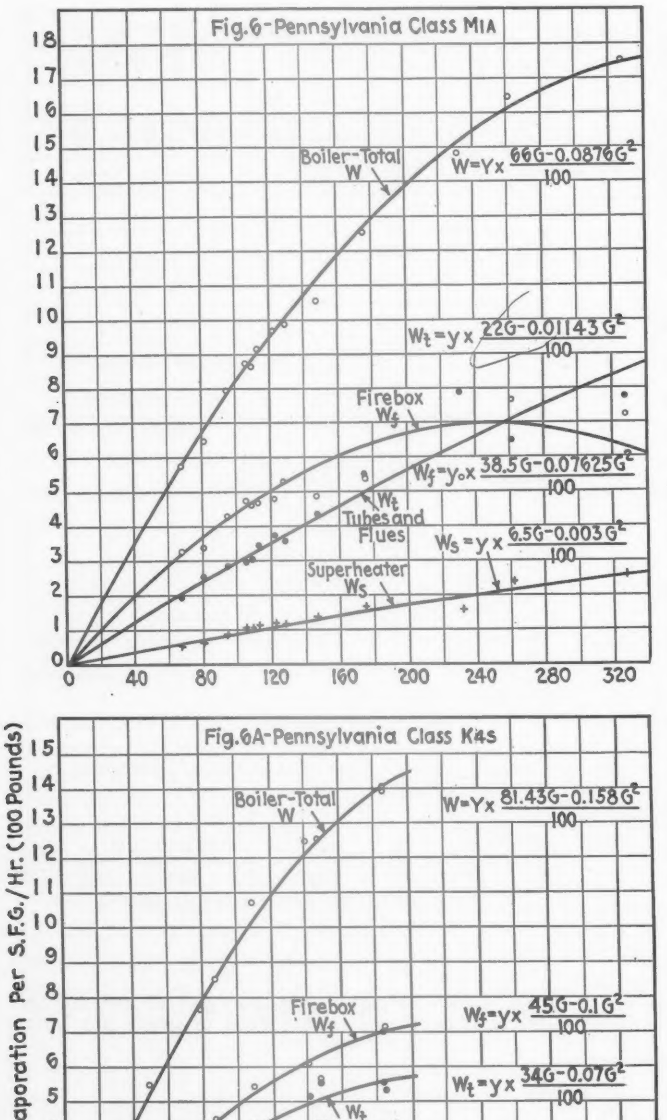


Fig. 5—Fuel burned as percentage of dry fuel fired per square foot of grate per hour



Figs. 6-6B—Evaporation of boiler and component parts as related to dry fuel fired per square foot of grate per hour

limit, which is 377 lb. per sfg/hr. The curve *Wf*, indicates that the firebox reached its limit of evaporation at a firing rate of 252.5 lb. per sfg/hr., or;—

$$G_{wf\,max.} = mf/2nf = 252.5$$

this is equivalent to a maximum heat transfer rate of 117,800 B.t.u. per hour per square foot of firebox heating surface. It is evident that in this boiler, the tube evaporation *Wt*, is responsible for the sustained capacity reached by the combination of elements.

The heat transferred across the superheating surface is nearly proportional to the firing rate, as indicated by the equivalent evaporation curve *Ws*. It should be noted that the evaporation of the firebox exceeds that of the tubes, up to a firing rate of 256 lb. per sfg/hr. At this rate the curves cross.

The most striking design characteristic of the M1a is its 98-in. combustion chamber, giving an average flame travel in firebox of 17 ft. 6 in. from firebed to flue sheet.

19—As indicating the extreme variations which characterize modern boiler designs, attention is directed to Fig. 6C, representing a test at Altoona of the Baldwin Locomotive Works' three-cylinder compound locomotive No. 60,000. This has a tubular firebox with 61-in. combustion chamber. The unique feature in the operation of this boiler is that the firebox evaporation curve *Wf*, falls well below that of the tubes and flues *Wt*, at all firing rates, notwithstanding the fact that the firebox heating surface of 772 sq. ft. is nearly double that of an equivalent stayed firebox. So far as the writer knows, this is the first instance in which it has been possible to draw a comparison between the evaporative efficiency of a tubular and a stayed firebox.

The trend of curve *Wt*, indicates that the tube evaporation would have reached its limit at a firing rate of 162 lb. per sfg/hr. whereas the firebox would have attained its maximum at a rate of 257 lb. It is further evident, as in the last case, that the curves *Wf*, and *Wt*, would cross at some higher rate of firing.

20—The total and component evaporation of the Pennsylvania class I1s, is indicated by Fig. 6B. This exhibit is not particularly conclusive as only three tests are available. These, however, show the same trend as do similar boilers with more adequate test data. In the I1s boiler, the total evaporation reaches its limit at a firing rate of 208 lb. per sfg/hr., as determined from data covering the complete test. The tabulated data indicate that the firebox curve *Wf* reaches its maximum at a firing rate of 155 lb. per sfg/hr., crossing the tube evaporation at a firing rate of 185 lb.

In this instance, as for the M1a, the total evaporation is sustained by the tubes and flues, after the firebox has reached its limit at a heat transfer rate of 126,400 B.t.u. per hour per sq. ft. of heating surface.

In the I1s, the equivalent evaporation of the superheater *Ws*, apparently begins to decline at a firing rate of 200 lb. per sfg/hr. This phenomena is not shown in any other test and is probably due to inadequacy of the data.

In comparing the I1s with the B.L.W. No. 60,000, it is of interest to note from Table 21,* that the fuel characteristics of both locomotives are identical.

21—A special test of the Pennsylvania class K4s is represented by Fig. 6A. In this locomotive the efficiency is so well sustained at high combustion rates that there is no apparent tendency for the curves *Wf* and *Wt* to reach a limit or to cross, within the range of firing. Equation (13), shows that the evaporative limit of the firebox and tubes would be reached at firing rates of 225 lb. and 243 lb. per sfg/hr. respectively.

* See page 240.

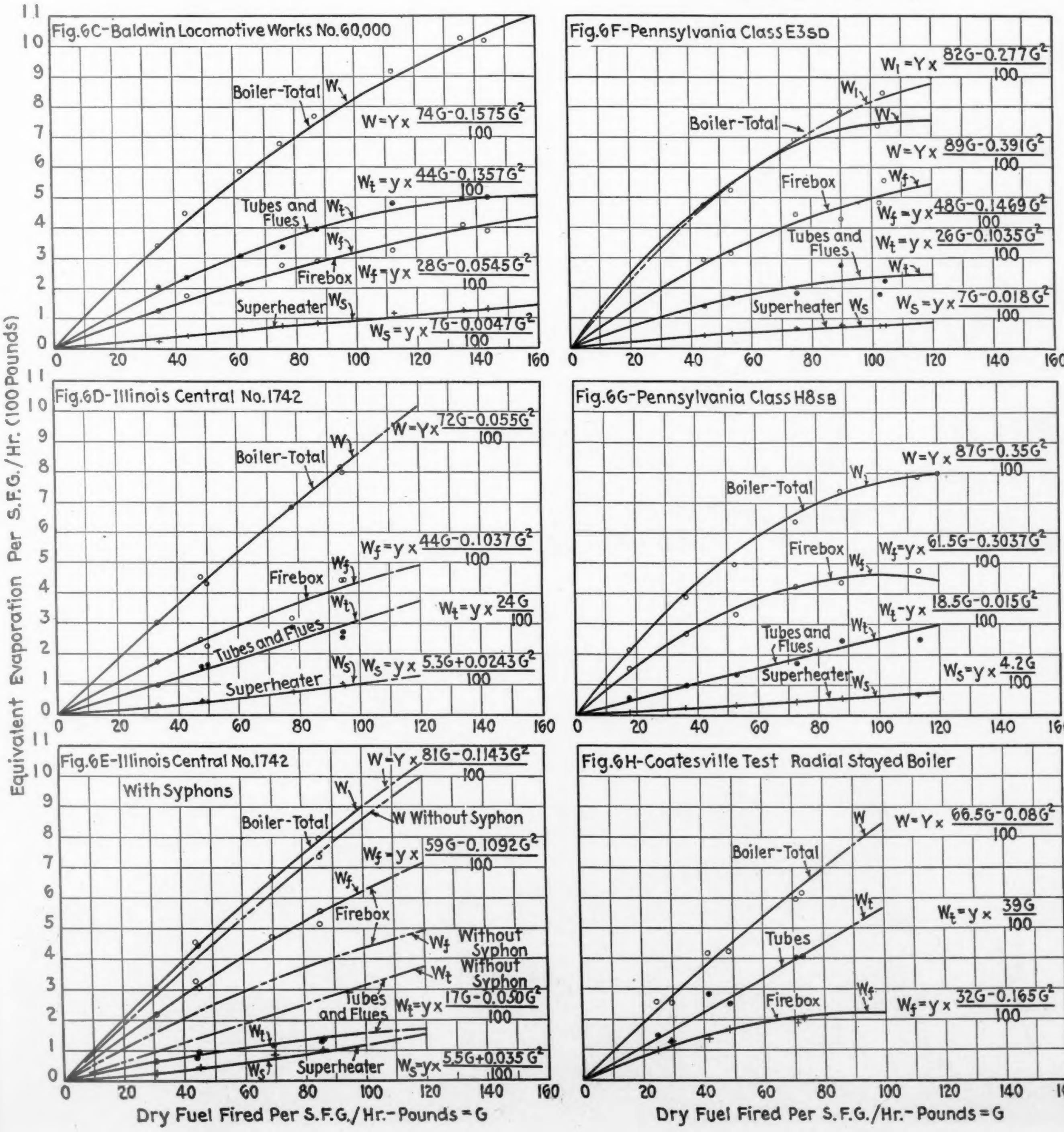
The peculiarity of this locomotive is that it was equipped with a special front end arrangement and exhaust nozzle, both of which proved highly efficient in promoting sustained boiler capacity.

22—In the next example to be considered, we have a case in which exactly the same boiler and similar fuel characteristics were used. The only variable was an increase in firebox heating surface by the substitution of Nicholson Thermic Syphons for arch tubes. The relative heating surface before and after application of the syphons is shown in Table 20.

Test of the original stayed firebox without syphon is represented by Fig. 6D. The curve *Wf*, is typical for the rather narrow range of firing that is distinctive of this test, its equation indicates that the evaporative limit would be reached at a firing rate of 212 lb. per sfg/hr. The curve *Wt*, in this instance approaches a straight line. It will be observed that the equivalent evaporation of the superheater *Ws*, reverses the normal trend, increasing more rapidly in relation to the firing rate.

The application of syphons to the boiler resulted in a surprising difference in the relative evaporation of the component elements, as indicated in Fig. 6E. At a firing rate of 100 lb. per sfg/hr. the total evaporation of the syphon equipped boiler was about five per cent greater than the non-syphon, as is shown by complete data from both tests. On the other hand, the firebox evaporation increased 47 per cent and the tube and flue evaporation decreased 50 per cent on the syphon equipped boiler. This is rather remarkable when it is considered that the firebox heating surface was increased

(Continued on page 240)

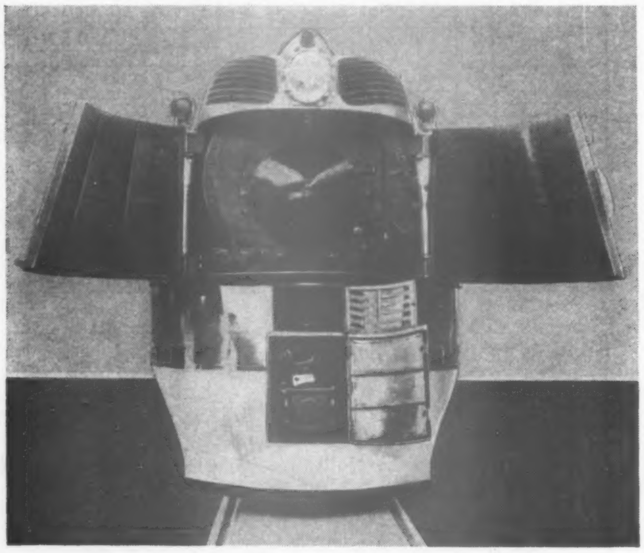


Figs. 6C-6H—Evaporation of boiler and component parts as related to dry fuel fired per sfg/hr.

Milwaukee Streamlined High-Speed Locomotives

Advanced 4-4-2 type built by American Locomotive Company to handle "Hiawatha" trains on 410-mile run from Chicago to Twin Cities in six and one-half hours

TWO high-speed streamlined passenger locomotives of a new and strictly modern design were delivered to the Chicago, Milwaukee, St. Paul & Pacific in May by the builder, the American Locomotive Company. These locomotives were designed to haul the new "Hiawatha" trains on daylight runs between Chicago and the Twin Cities, 410 miles, with five intermediate stops, on a six and one-half hour schedule—an average start-to-stop speed of 63.1 m.p.h. or an average running speed of 66 m.p.h. These trains of six cars each weigh 340 tons, exclusive of passengers and baggage. All cars are of new design and built by the road for this service. One of the locomotives, on a trial trip before being placed in service, made the run from Milwaukee to New Lisbon, 141 miles, in 113 min., or at an average speed of 74.9 m.p.h. The maximum speed reached was 111.5 m.p.h. On the return trip the train, consisting of the locomotive, a dynamometer car, and five coaches, was stopped from a speed of 100 m.p.h. in 6,600 ft.



Front doors and grille opened for access to front end, coupler and bell

A striking and pleasing appearance was obtained by shrouding the upper portion of the locomotive and using a partial skirting below the running boards, this skirting being extended downward at the front to replace the pilot. No attempt was made to conceal the running gear. The smooth appearance and clean lines are enhanced by the color scheme adopted for the locomotive and tender and by a touch of appropriate ornamentation at the front end. The finish includes black, gray, orange yellow, maroon and brown, with lettering in gold leaf and the conventionalized Indian headdress on the shrouding front in polished chromium. In arranging the shrouding and skirting to permit ready access to all concealed apparatus great care and ingenuity were exercised to keep the exterior surfaces free from bolt heads, nuts or other projections.

These locomotives are of the 4-4-2 type; weigh 280,000 lb., of which 140,000 lb. is on the drivers, and have a rated tractive force of 30,700 lb. The driving wheels are 84 in. in diameter, the cylinders are 19 in. by 28 in., and the oil-fired boiler carries a pressure of 300 lb. per sq. in.

The Boiler

The straight top boiler, which is of generous capacity, embodies a conventional stayed firebox and fire-tube shell. The barrel is rolled in two courses, the dome being located on the forward course, 7 ft. back from the

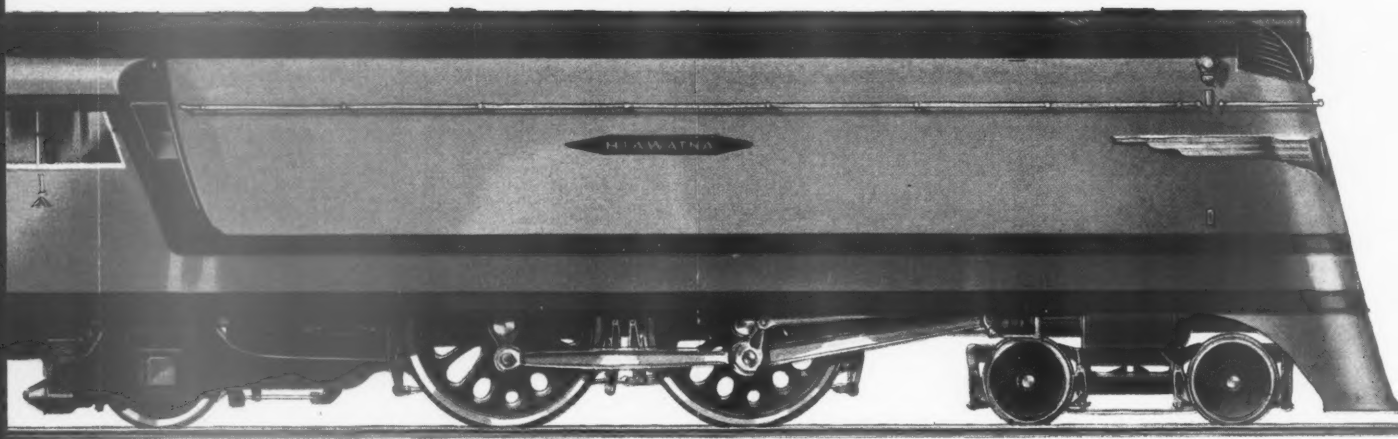
View of the Milwaukee locomotive before the shrouding was applied

High-Speed Locomotive for the Milwaukee's "Hiawath

Built in 1935 by the American Locomotive Company

Type	4-4-2
Name (of train)	Hiawatha
Height to top of stack	14 ft., 4 in.
Width	10 ft., $2\frac{3}{8}$ in.
Cylinders, diameter and stroke	19 in. by 28 in.
Valve gear, type	Walschaert
Valves, piston type:	
Size	10 in.
Maximum travel	$6\frac{1}{2}$ in.
Cut-off in full gear, per cent	85
Weights in working order:	
On drivers	140,000 lb.
On front truck	75,000 lb.
On trailing truck	65,000 lb.
Total engine	280,000 lb.
Tender	247,500 lb.

Wheel bases:	
Driving	8 ft., 6 in.
Total engine	37 ft., 7 in.
Total engine and tender	78 ft., $10\frac{1}{2}$ in
Wheels, diameter outside tires:	
Driving	84 in.
Front truck	36 in.
Trailer	51 in.
Boiler:	
Type	Straight top
Steam pressure	300 lb. per sq. in.
Fuel	Oil
Diameter, first ring, outside	$78\frac{5}{16}$ in.
Firebox, length and width	$132\frac{1}{16}$ in. by $75\frac{3}{16}$ in.
Tubes, number and diameter	160-$2\frac{1}{4}$ in.
Flues, number and diameter	43-$5\frac{1}{2}$ in.



for the Milwaukee's "Hiawatha" Train

he American Locomotive Company

	........8 ft., 6 in.
:	........37 ft., 7 in.
: and tender	.......78 ft., 10½ in
ter outside tires:	
	........84 in.
	........36 in.
	........51 in.
	........Straight top
sure	.........300 lb. per sq. in.
	........Oil
rst ring, outside	.........78$\frac{5}{16}$ in.
gth and width	..132$\frac{1}{16}$ in. by 75$\frac{3}{16}$ in.
ber and diameter	.....160–2¼ in.
ber and diameter	.......43–5½ in.

Boiler (cont'd):

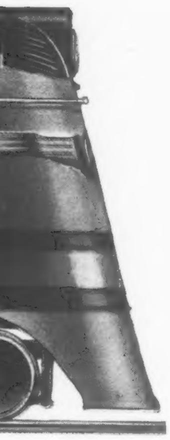
Length over tube sheets	19 ft., 0 in.
Grate area	69 sq. ft.

Heating surfaces:

Firebox	254 sq. ft.
Syphons	40 sq. ft.
Tubes	1,781 sq. ft.
Flues	1,170 sq. ft.
Total evaporating	3,245 sq. ft.
Superheating	1,029 sq. ft.
Combined evap. and superheat	4,274 sq. ft.

Tender:

Style	Built-in fuel tank
Fuel capacity	4,000 gal.
Water capacity	13,000 gal.
Rated tractive force	30,700 lb.
Weight on drivers÷tractive force	4.56



front tube sheet. The front shell course is 13/16 in. in thickness and has an inside diameter of 79-11/16 in. The second and larger shell course, which is 80 in. in diameter outside, is rolled from plate 27/32 in. in thickness. The boiler-shell courses, including the welt strips and the firebox wrapper sheets, are of Lukens silicon-manganese steel.

The firebox sheets are of Lukens firebox steel built up on a solid cast-steel mud ring and stayed with Lewis Special staybolt iron. The stays are 1 in., 1-1/16 in. and 1⅛ in. in diameter and include a liberal application of flexible stays at the breakage zones. A Thermic syphon is fitted in the firebox.

There are 160 tubes, 2¼ in. in diameter and 43 flues, 5½ in. in diameter, the length over tube sheets being 19 ft. The firebox measures 132-1/16 in. by 75-3/16 in., inside, and provides an equivalent grate area of 69 sq. ft. The combined heating surface is 4,274 sq. ft., of which 294 sq. ft. is in the firebox and syphon, 2,951 sq. ft. in the tubes and flues, and 1,029 sq. ft. in the Type A superheater. The gas area through the tubes and flues is 1,078 sq. in. and the area under the table plate in the smokebox is 1,770 sq. in.

The firebox is of welded construction throughout. Welding is also used for 12 in. from the ends along the longitudinal shell seams and the edges of the wrapper sheets are welded at all corners 12 in. up from the bottom of the mud ring. Both the firebox and wrapper sheets are also seal welded to the mud ring behind obstructions which would make access for calking difficult.

The locomotive is equipped with a Wilson water-conditioner, feed pump, sludge remover and blow-off cocks. A Hancock Type W non-lifting injector is also provided. The Hancock boiler feed check valves are located on the upper quarters midway between the dome and the front bue sheet. Washout plugs are of the T-Z pattern. A Barco low-water alarm is also included.

The boiler is supported on sliding shoes at both the front and back ends of the firebox. Between the driving wheels and at the guide yoke are waist sheets which have sliding fits on the boiler shell.

The Front End

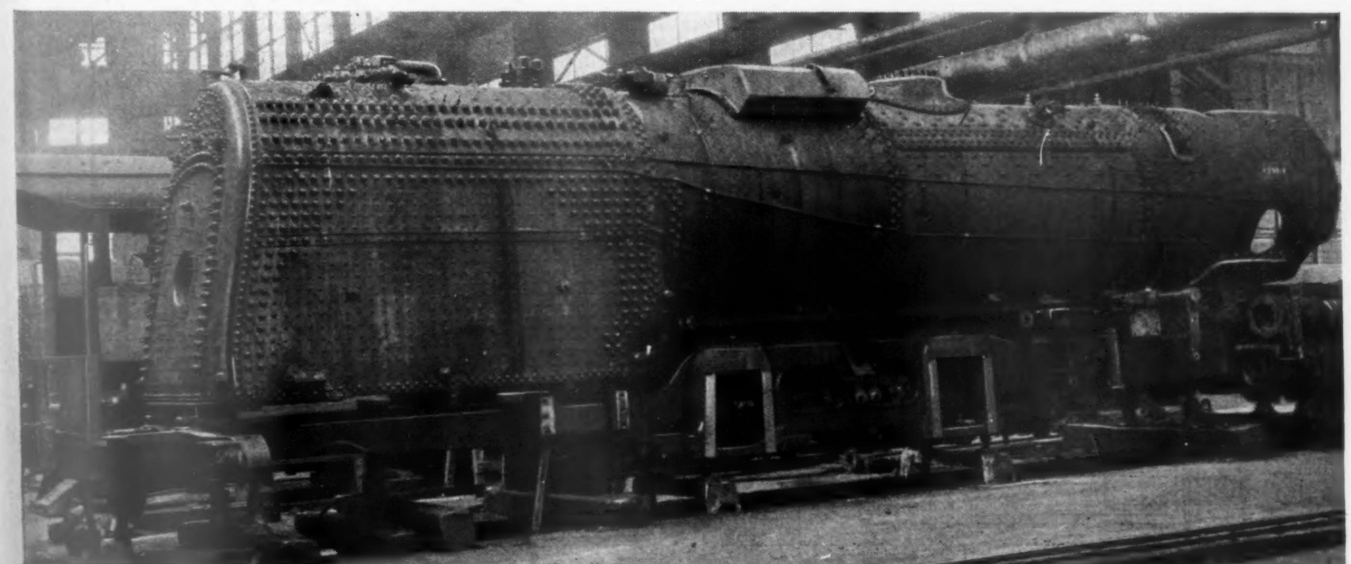
An unusual feature of the front end is the exclusion of the volume in front of the diaphragm and above the table plate from the smokebox proper. The table plate which extends forward to the smokebox front is provided with an opening to which the bottom of the stack extension is fitted. Since the fuel is oil, no front-end screen is needed. The exhaust nozzle is relatively low, the Goodfellow tip standing 19⅞ in. from the bottom of the smoke arch and 12⅛ in. below the bottom of the stack extension and table plate. The smokestack has a diameter of 18½ in. at the choke and a total height of 60³⁄₁₆ in., the top being 14 ft. 4 in. above the rail.

Advantage has been taken of the fact that the smokestack is concealed to use it as a support for the shrouding, the necessary bolting lugs being cast on it, both in front and at the rear. A vertical passage of circular section which extends up to the top of the stack also forms an integral part of the casting at the rear. This is provided with a suitable connecting flange at the base and serves as an exhaust pipe for the feedwater pump and the turbo-generator. The moisture from these exhausts is thus kept out of the smokebox. The air-pump exhaust is piped into the main exhaust passage in the cylinder saddle. Grilles at the top of the front of the shrouding admit air to a duct which has an outlet behind the stack where it serves as a smoke lifter. The entire front end is lagged and jacketed to keep down the temperature inside the shrouding. The smokebox front is swung on Okadee hinges.

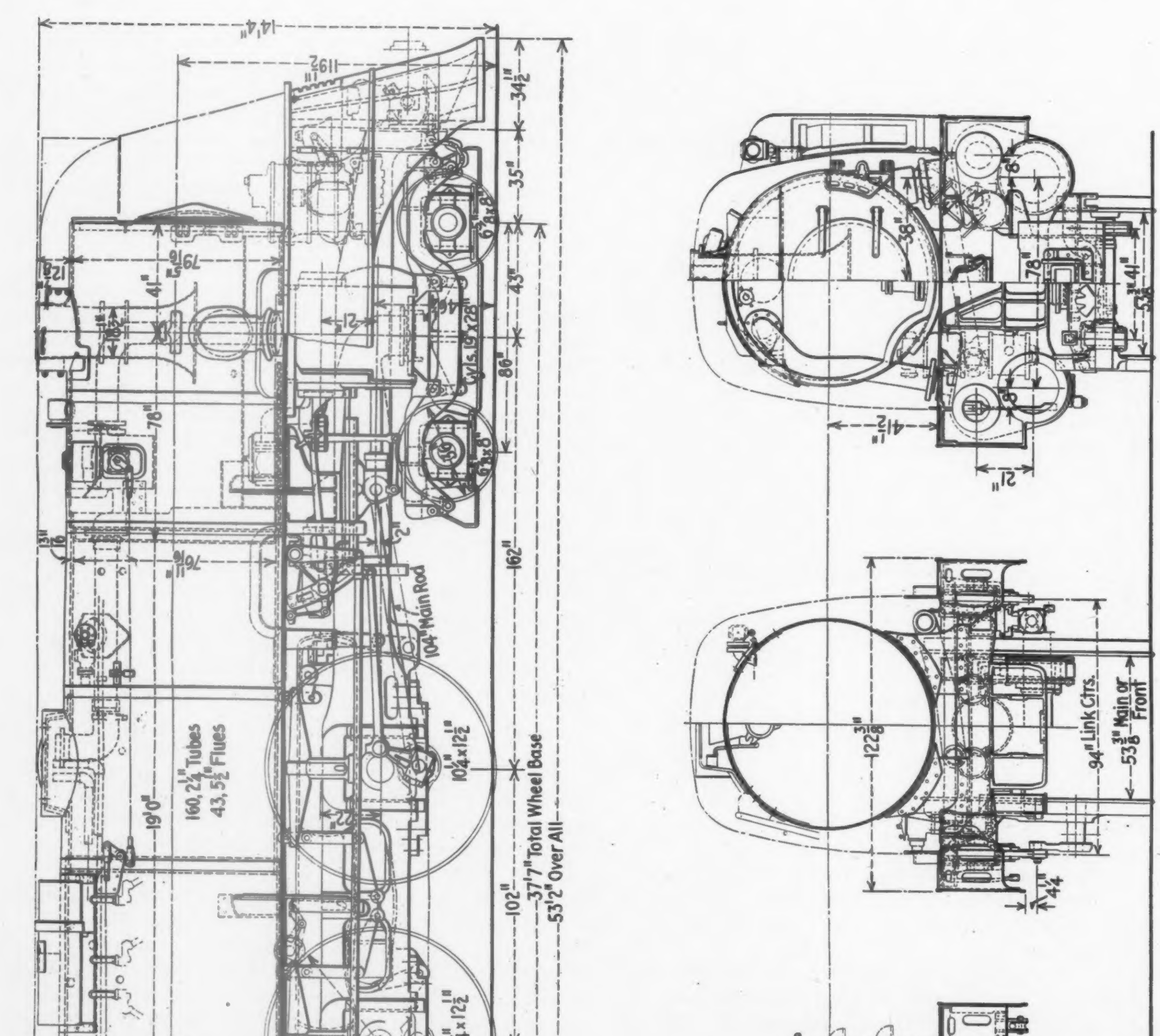
Foundation, Running and Driving Gear

The locomotive is assembled on a cast-steel bed, of which the cylinders, back cylinder heads, saddle and main air reservoir are integral parts. Provision is also made for the support of the running boards on the bed casting, either directly or from waist-sheet and other bed-casting connections. The shrouding and skirting are, in turn, supported from the running boards. In front of the cylinders the casting includes suitable brackets for the air pump, turbo-generator and bell. The bed terminates at the front in a deep vertical bolting face, to which are attached the front coupler pocket and the pilot or nose structure of the shrouding. No bumper beam is provided.

The driving wheels have Boxpok cast-steel centers which are mounted on hollow-bored axles. The driving journal boxes are fitted with SKF roller bearings. The engine truck is the Commonweal four-wheel type, with



The boiler mounted on engine bed—Note application of flexible staybolts



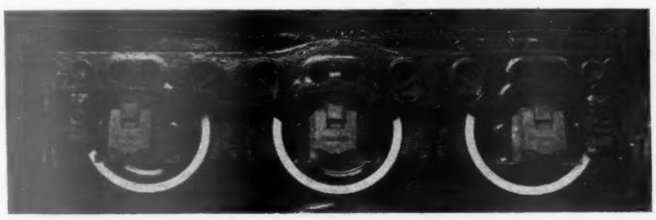
Elevation and cross-sections of the Chicago, Milwaukee, St. Paul & Pacific high-speed streamlined locomotive

inside journals. The trailing truck is the Commonwealth Delta type with a single axle. SKF bearings are applied on the hollow-bored axles of the engine truck, while the trailing truck has an American Steel Foundries roller-bearing axle assembly fitted with Timken roller bearings.

In the rods and motion work weight reduction was an important consideration in view of the high speeds for which this locomotive was designed. The drive is

The two-wheel trailer truck

through Tandem main rods, with the cylinders spread 78 in. between centers. The rods are of high-tensile nickel steel and are light I-sections. For stiffness the parallel rod is fish-belly in form. The eccentric rod and crank are also channeled to keep down the weight on the main crank pins. The counterbalancing of the locomotive is such that the dynamic augment at the rail at a speed of 100 m.p.h. is 10,800 lb. The total reciprocating weights on one side of the locomotive amount to



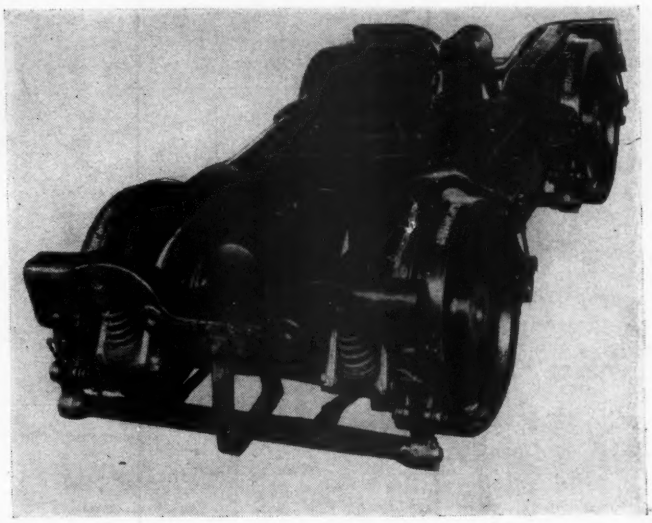
Six-wheel truck on front of tender

1,003 lb., of which one-third are balanced. The low dynamic augment is due in part to the care in design to keep the weights of reciprocating parts as low as possible and also to the greatly reduced overhang of the pin-borne weights due to the relatively narrow cylinder spread.

The crank-pin bearings are bronze floating bushings, inside of Hunt-Spiller gun iron bushings pressed in the rods at the rear pins and in the steel articulating bushings of the rods at the front pins. The crank pins are of carbon steel, hollow bored.

The suspension is of the customary three-point type. In addition to the main driving and trailing-truck springs, each side suspension includes two coil cushioning springs—one lever-connected to the front driving-spring hanger and the other interposed directly between the end of the rear trailer-spring hanger and the Delta trailer-truck frame. The driving springs have a slight reverse camber.

The pistons are light Z-section, open-hearth-steel forgings fitted with Hunt-Spiller Duplex packing. Bronze wearing faces are provided at the bottom. The crossheads and guides are of the Dean three-bar type,

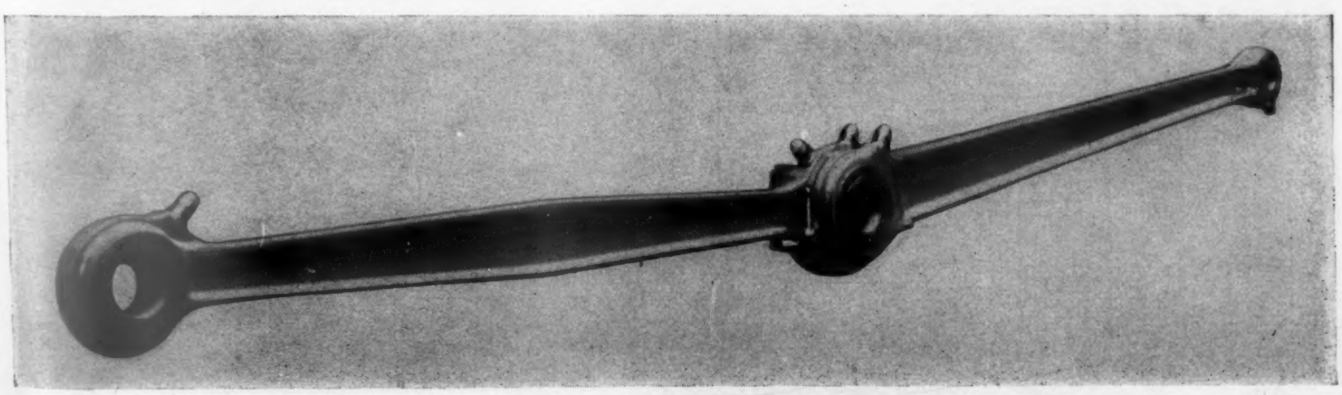


The engine truck is equipped with clasp brakes operated by two brake cylinders

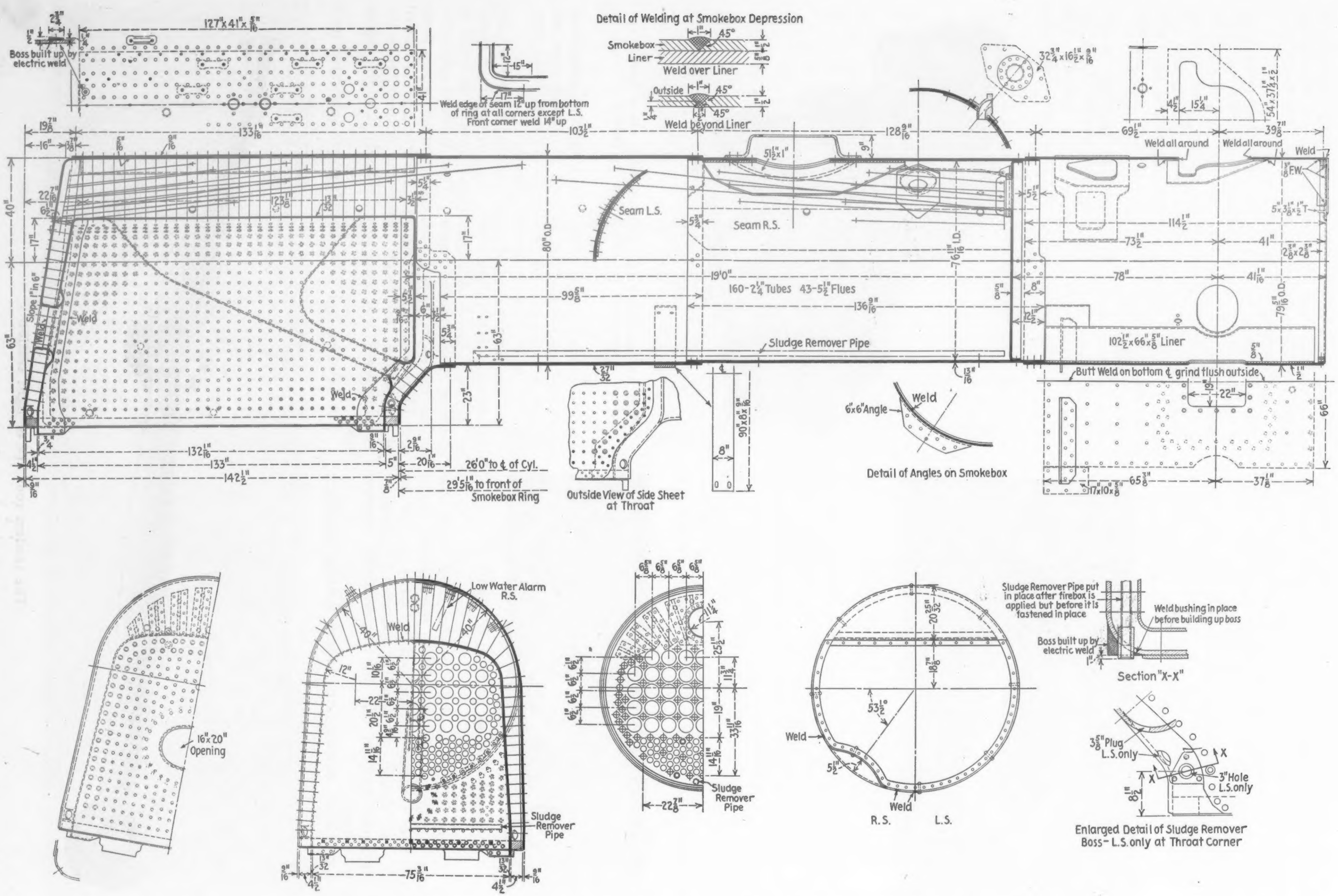
Ampco bronze shoes being fitted to the crosshead. Diamond-Crescent packing is used for piston rods and valve stems, the packing for the piston rods being suitable for steam temperatures of 750 deg. F.

The locomotive is fitted with Walschaert valve motion and 10-in. piston valves which have a maximum travel of 6½ in. An American multiple throttle is fitted in the type A superheater header. The latter is connected to the valve chambers by the usual outside steam pipes and Flextite casings. The Alco reverse gear is located at the side of the firebox, behind the skirting below the running board, and is supported directly from the engine bed.

The cylinder and valve chambers are lubricated by a



The tandem rods are of light section

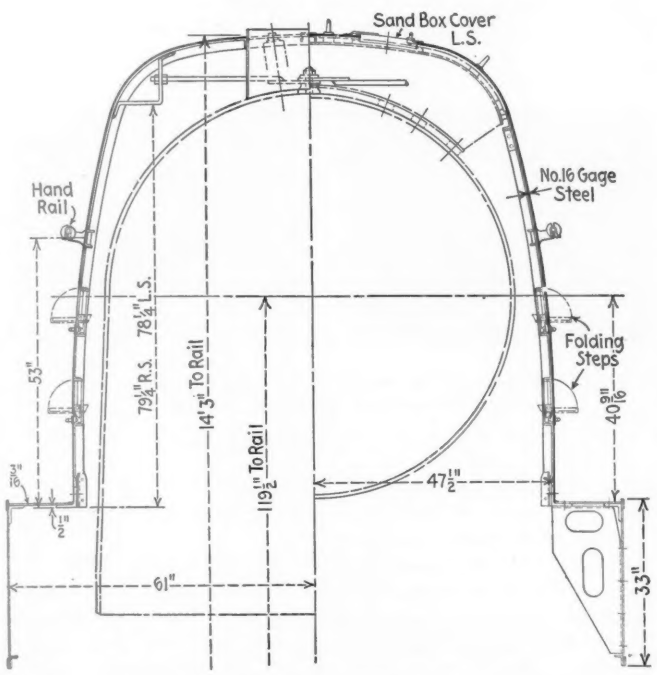


Longitudinal and transverse sections of the boiler of the Milwaukee 4-4-2 type locomotive

Nathan DV-4 24-pint force-feed lubricator. A Nathan Type LB mechanical lubricator supplies oil to the steam cylinders of the air compressor, the air cylinders being lubricated by Westinghouse Type B oil cups. The valve motion, rods, spring rigging and brake work are fitted for Alemite lubrication throughout.

Brakes and Brake Rigging

The locomotives are fitted with Westinghouse 8 ET air-brake equipment and one 8½-in. c.c. air compressor. The main reservoir, which is a part of the backbone of



Section through shrouding and skirting

the engine bed, is divided into three compartments. Between the air compressor and the first compartment of the reservoir and between the first and second compartments are radiating pipes. The rear compartment, which is small, is connected to the second by a cored passage near the top of the dividing wall and serves as a final moisture settling chamber before the compressed air is drawn into the brake system.

A new and unusual development embodied in these locomotives is the foundation brake, designed by the American Brake Company. This is particularly adapted to the dissipation of the large amount of energy stored in the locomotive when moving at speeds of 90 m.p.h. and upward. Clasp brakes are applied on every wheel under the locomotive. The engine truck is provided with two brake cylinders, one of which applies the brake shoes against the front and the other against the rear of all four wheels. To steady the truck frame against the tilting action of the brake application the ends of the equalizers are extended beyond their bearings on tops of the journal boxes to support the seats for coil cushioning springs under the four corners of the engine-truck frame.

The driver brakes are operated by three cylinders. The front brake shoes on all four driving wheels are applied by a single cylinder through mechanical equalization, while the rear shoes on each side of the locomotive have separate cylinders, the equalization between the two sides of the locomotive being effected pneumatically. One brake cylinder applies all four shoes on the trailing-truck wheels.

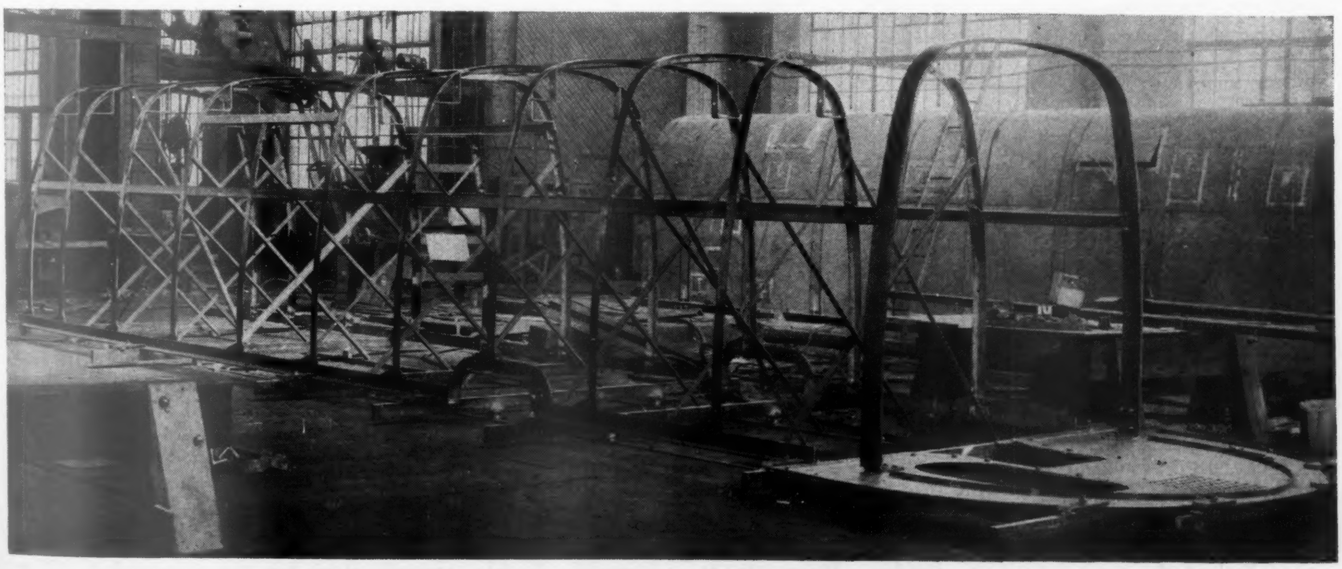
The braking ratios of the three brake systems are, respectively, 45 per cent for the engine truck, 60 per cent for the trailing truck, and 78 per cent for the driving wheels, based on 50 lb. brake-cylinder pressure.

The tender trucks are equipped with Simplex unit type clasp brakes.

The Tender

The rectangular tender is built up by welding upon a General Steel Castings water-bottom frame. As it is designed to be used in oil-burning service only, the fuel tank is built in integrally. The hot-water compartment of the Wilson water conditioner is located on the left side of the water tank at the front and receives exhaust steam from the back end of the cylinder exhaust ports through pipes which are carried between the frames and under the draft pan to the tender.

The top of the tank is shrouded to conform with the contour of the roofs of the new cars with which these locomotives will be operated. A single opening in this shrouding provides access to both water and oil-filling



Shrouding frame in foreground with nearly completed shrouding in background

holes. The rear end of the tender is fitted with a dummy vestibule connection. The tender is carried on a six-wheel truck in front and a four-wheel truck at the back. Both trucks are of General Steel Castings construction and fitted with American Steel Foundries roller-bearing wheel-and-axle units having Timken bearings. Davis cast-steel wheels are applied.

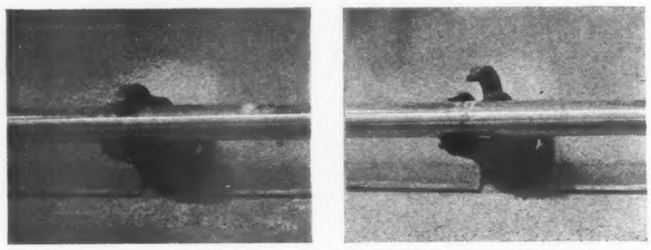
Principal Dimensions, Weights and Proportions of the C. M. St. P. & P. streamlined Locomotives

Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	"Hiawatha" 4-4-2
Road numbers	1-2
Service	High-speed pass.
Height to top of stack	14 ft. 4 in.
Width	10 ft. 2⅜ in.
Cylinders, diameter and stroke	19 in. by 28 in.
Valve gear, type	Walschaert
Valves, piston type, size	10 in.
Maximum travel	6½ in.
Steam lap	1⅛ in.
Exhaust clearance	¼ in.
Lead	¼ in.
Cut-off in full gear, per cent	85
Weights in working order:	
On drivers	140,000 lb.
On front truck	75,000 lb.
On trailing truck	65,000 lb.
Total engine	280,000 lb.
Tender	247,500 lb.
Wheel bases:	
Driving	8 ft. 6 in.
Total engine	37 ft. 7 in.
Total engine and tender	78 ft. 10½ in.
Wheels, diameter outside tires:	
Driving	84 in.
Front truck	36 in.
Trailing truck	51 in.
Journals, diameter and length:	
Driving, both axles	10¼ in. by 12½ in.
Front truck	6⅝ in. by 8 in.
Trailing truck	7 in. by 12 in.
Boiler:	
Type	Straight-top
Steam pressure	300 lb.
Fuel	Oil
Diameter, first ring, inside	76¹¹/₁₆ in.
Diameter, largest, outside	80 in.
Firebox, length and width	132¹/₁₆ in. by 75³/₁₆ in.
Height mud ring to crown sheet, back and front	80 in.
Syphons	One
Tubes, number and diameter	160—2¼ in.
Flues, number and diameter	43—5½ in.
Length over tube sheets	19 ft. 0 in.
Total gas area through tubes and flues	1,078 sq. in.
Grate area	69 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	254 sq. ft.
Syphon (1)	40 sq. ft.
Firebox, total	294 sq. ft.
Tubes	1,781 sq. ft.
Flues	1,170 sq. ft.
Tubes and flues	3,951 sq. ft.
Total evaporative	3,245 sq. ft.
Superheating (Type A)	1,029 sq. ft.
Combined evap. and superheat	4,274 sq. ft.
Water conditioner	Wilson
Tender:	
Style	Built-in fuel tank
Water capacity	13,000 gal.
Fuel capacity (oil)	4,000 gal.
General data estimated:	
Rated tractive force, 85 per cent	30,700 lb.
Speed at 1,000 ft. piston speed	53.55 m.p.h.
Piston speed at 10 m.p.h	186.5 ft. per min.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	50
Weight on drivers ÷ tractive force	4.56
Total weight engine ÷ comb. heat. surface	65.5
Boiler proportions:	
Tractive force ÷ comb. heat. surface	7.18
Tractive force × dia. drivers ÷ comb. heat. surface	603
Firebox heat. surface, per cent. comb. heat. surface	6.87
Tube and flue heat. surface, per cent comb. heat surface	69.05
Superheat. surface, per cent comb. heat. surface	24.08
Firebox heat. surface ÷ grate area	4.26
Tube and flue heat. surface ÷ grate area	42.77
Superheat. surface ÷ grate area	14.92
Comb. heat. surface ÷ grate area	61.94
Gas area, tubes and flues ÷ grate area	0.109

Franklin radial buffer and Unit safety engine and tender drawbar are fitted. Miner A-94-XB draft gear is installed at the rear end of the tender. Barco steam, air and fuel-oil connections are applied between the engine and tender, with T-Z tank valves and hose connections for water. Barco brake-cylinder connections are also used on the engine, trailer and tender trucks.

Cab, Fittings and Shrouding

Since the locomotive and tender are built for oil-burning service only, there was no need for access to the tender through the arch at the rear of the cab. The back of the cab has, therefore, been completely enclosed and provided with side doors. The cab is of welded construction with one thickness of American hair felt insulation between the outside sheets and the inside wood lining. The engineman's and fireman's seats are Gustin-Bacon type with Spongex cushions. Two auxiliary drop seats are also provided at the back and are fitted with the same type of cushions. The cabs are fitted with Prime clear-vision windows.



Hand rail column in closed and locked position at left and in opened position at right

Because of the inaccessibility of the tender while the locomotive is running the cab is fitted with water-and-oil-level indicators, accompanying which is a calibration chart showing the gallons per inch of fuel and water heights. There is also a dial type pyrometer which shows the temperature of the fuel oil in the tank.

There are two steam turrets. That for superheated steam is located on the smokebox near the superheater header and supplies steam for the air pump, the turbo-generator, the blower line, the oil burner and the cylinder cocks. The saturated-steam turret is placed in the conventional location just ahead of the cab and supplies the injector, steam heat for the train and cab, the power reverse gear, the feedwater pump and the lubricator heater. The locomotive is equipped with an Ashcroft back-pressure gage, a Loco Recorder, reading up to 120 m.p.h., and Union Coded continuous cab signals.

The headlight is the Pyle-National submerged type, with a 14-in. glass reflector, arranged to swing out. The special oval front goggle is mounted in a cast aluminum frame. The locomotive has a Leslie Tyfon whistle fitted for operation by air or steam. The single horn is enclosed within the cowling immediately above the headlight. The sand box which is concealed by the shrouding is of rectangular form, welded construction and has a capacity of 25 cu. ft. Brewster-White remote-control type sanders are applied, the control valves being located at the sand traps with direct air connections from the main reservoir and a pneumatic operating valve in the cab. This arrangement is designed to provide a flow of sand immediately on the operation of the cab valve.

The shrouding completely encloses the boiler and all apparatus customarily suspended from the boiler or mounted on the locomotive bed. Extending down to the running board, it is built of No. 16 gage material—Toncan steel for the doors ahead of the smokebox and Republic double-strength steel for the remainder. The sheets are carried on a frame consisting of angle car-

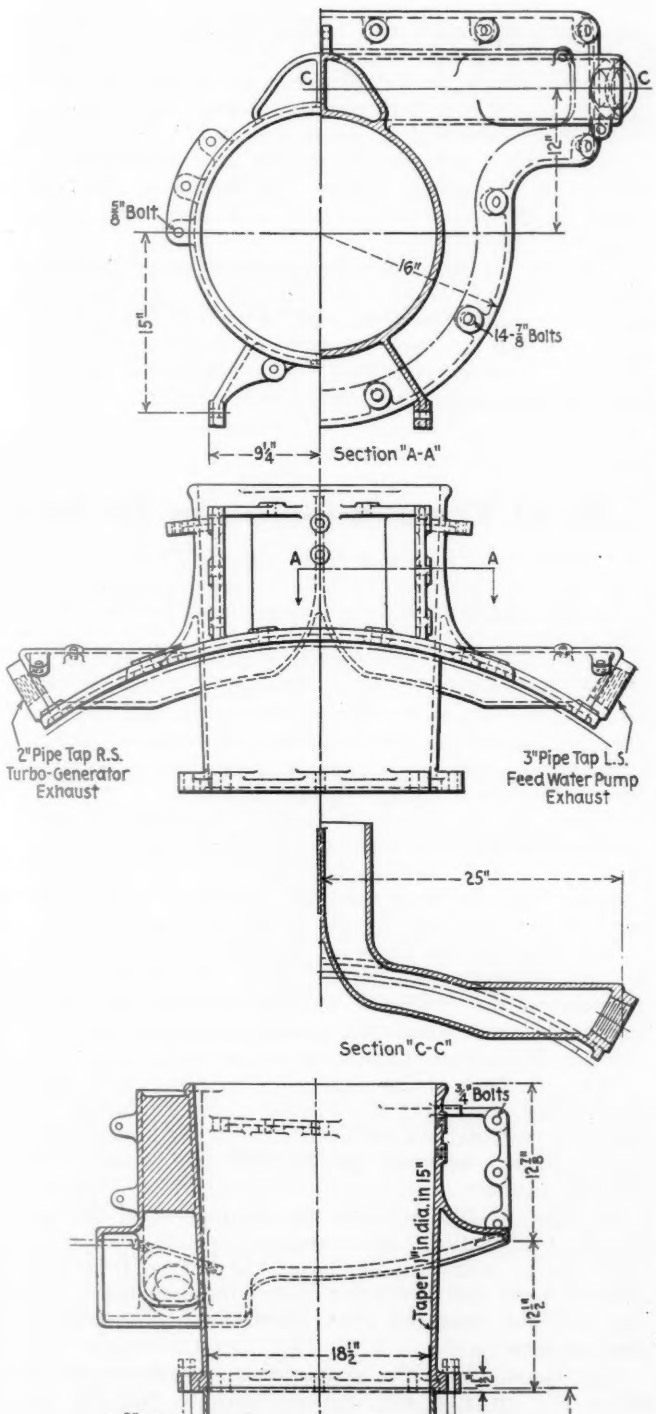
lines which are supported from the running boards and braced to the top of the boiler. The shrouding is fitted with doors, opposite all washout plugs, sand traps, boiler checks, etc. The entire front is enclosed in swinging doors, the opening of which gives access to the front end and the equipment mounted on the front deck.

Among the interesting details of the shrouding are folding steps in the sides which can be let down when access to the sand box or cab turret is desired. The classification lamps are supported on top of the upper hinges of the front shrouding doors and these hinges have been designed so that the wiring is carried through them to the jacket. The handrail columns are fitted with simple spring latches, by means of which the handrail is securely locked in the columns. Each is unlocked by a push button and opened by spring torsion. Closing the latches automatically locks them in place. An entire side section of the handrail can thus be removed and replaced in a few minutes without the use of tools.

The lower section at the front end of the shrouding serves as a pilot. This is a stiff, welded structure of plates and angles which extends from below the bottom of the front-end shrouding doors. A panel on the center of the pilot conceals the coupler when it is not in use. The coupler is hinged in its pocket to swing upward and when its use is required, on removal of the panel, it can be swung down horizontally. Train-brake and air signal lines are carried to the front of the locomotive, where they terminate inside the shrouding with standard cut-out cocks. The air hose, when not in use, are removed and carried in the concealed tool box.

The skirting is supported from the outer edge of the running boards and extends down about 33 in. This conceals the reverse gear, the boiler feed pump, the spring rigging and most of the valve motion, and forms an unbroken line from the rear of the pilot to the rear of the tender.

* * *



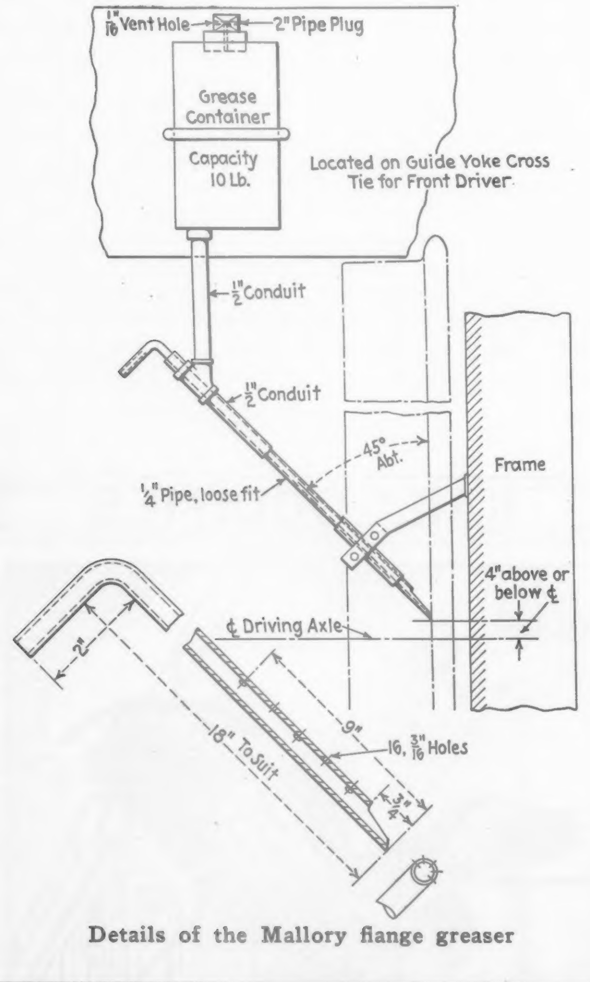
Smokestack and extension with auxiliary exhausts and support for shrouding

Further information furnished by the Editor upon request

Locomotive Flange Greaser

A DEVICE for applying a limited quantity of grease to the flanges of a locomotive has been designed and patented by W. V. Mallory, enginehouse foreman, Acca terminal, Richmond, Va., of the Richmond, Fredericksburg & Potomac. This greaser has been applied to a number of locomotives on the R. F. & P. and is reported to be working very satisfactorily.

The Mallory flange lubricator differs from most others in that it applies grease instead of oil to the locomotive driving-wheel flanges, grease being chosen because of the lessened danger of the spread of the lubricant onto the wheel tread. As will be noted from the drawing, the greaser consists of a container attached to any convenient part of the locomotive, a connecting section of pipe and the lubricator proper. The latter is made up of a short section of ½-in. conduit, inside of which a piece of ¼-in. pipe fits loosely. The inner pipe or feeding tube is perforated at the lower end with a number of small holes and has a tapered opening at the end which contacts with the driving-wheel flange. In service the lateral motion of the wheel causes the feeding tube alternately to slide upward and gravitate downward, thus carrying down a small quantity of grease and permitting it to be fed to the wheel flange. When the locomotive is standing no movement occurs and the feed is automatically stopped.



Details of the Mallory flange greaser

The best consistency of the grease used depends on climatic conditions as determined by experience. The container usually employed has a capacity for 10 lb. of grease, which has been found to be sufficient for several thousand locomotive miles. The greaser is simple in construction, inexpensive and easily applied.

Heat Transmission in Boilers

(*Continued from page 231*)

only 20.6 per cent and no change made in the tube or flue surface.

Another curious development which distinguished this test is that, notwithstanding the decreased temperature of the gases passing through the tubes and flues and the low rate of heat transfer from gas to water, the heat transferred over the superheating surface was greater than for the non-syphon equipped boiler.

23—A test of two older types of locomotives is represented by Figs. 6F and 6G, which exhibit evaporative data for the Pennsylvania Classes E3sd and H8sb, respectively. In these tests the temperature was measured in the rear end of the tubes and flues instead of in the front of the firebox. The effect of this, would, by the method used herein, show an excess of heat transfer in the firebox. The test results, particularly for the E3, are somewhat scattered but the curves developed from them appear to be normal.

Both of these boilers have 15-ft. tubes, with almost equal grate area, yet the characteristic equations indicate that the total evaporation of the E3 is limited by the tube transfer, whereas, for the H8 the firebox is the limiting factor.

In Figs. 6—6E and 6G, the summation of the component evaporations approximately equal that of the entire boiler, although the former is derived from a few selected tests and the latter from complete tests. This fact indicates that the tests selected for discussion are characteristic.

For Class E3sd the evaporation, as shown by the curve W_1 in Fig. 6F, applies only to the six tests enumerated in Tables 7 and 16. The evaporation for the complete series of tests, as given in Pennsylvania Bulletin No. 11, is represented by curve W. That these curves do not coincide indicate that the tests in which tube temperatures were taken are somewhat abnormal.

Table 21—Characteristics of Fuel Used in Tests

Road and Class of Locomotive	Description of Fuel	Ultimate Analysis: Carbon, Per Cent	Hydrogen, Per Cent	Nitrogen, Per Cent	Oxygen, Per Cent	Sulphur, Per Cent	Ash, Per Cent	Calorific Value of Dry Coal per Lb., B.t.u.	Minimum Products of Combustion per Pound of Fuel
Pennsylvania, Class M1a	Penna. Westmoreland Co. bituminous run-of-mine	77.8	5.0	1.6	4.9	1.7	9.0	13820	11.55
Pennsylvania, Class K4s	Penna. Westmoreland Co. bituminous screened	79.3	5.3	1.6	6.0	1.0	6.8	14073	11.75
Pennsylvania, Class I1s	Penna. Westmoreland Co. bituminous run-of-mine	74.2	5.2	1.4	7.1	1.7	10.4	13658	11.07
Baldwin Loco. Wks. No. 60,000	Penna. Westmoreland Co. bituminous run-of-mine	74.2	5.2	1.4	7.1	1.7	10.4	13704	11.07
Illinois Central, No. 1742	Ill. Williamson Co. No. 6 run-of-mine screened	68.1	5.2	1.1	9.2	3.8	12.6	12563	10.35
Ill. Central, 1742, with syphons	Ill. Williamson Co. No. 6 run-of-mine screened	68.1	5.2	1.1	9.2	3.8	12.6	12563	10.35
Pennsylvania, Class E3sd	Penna. Westmoreland Co. bituminous	79.2	5.1	1.5	6.2	1.6	6.4	14392	11.70
Pennsylvania, Class H8sb	Penna. Westmoreland Co. bituminous run-of-mine	76.0	4.9	1.4	5.9	1.8	10.0	14140	11.25

EDITORIALS

Meetings Scheduled for Mechanical Associations

Just before going to press we were advised that the Association of American Railroads had granted permission to the mechanical associations not included in its organization to hold business meetings at Chicago in September. Monday and Tuesday, September 16 and 17, have been designated by the Committee on Holding Meetings of the Co-ordinated Associations, for meetings of the Air Brake Association, Car Department Officers Association, International Railway General Foremen's Association and Traveling Engineers' Association. The following two days, Wednesday and Thursday, September 18 and 19, have been designated for meetings of the American Railway Tool Foremen's Association, International Railway Fuel Association, International Railway Master Blacksmiths' Association, and Master Boiler Makers' Association.

A hurried check-up by wire indicates that some of these associations may not attempt to schedule meetings in September, but that several of them are actively going forward with their programs. The Traveling Engineers' Association, for instance, has sent a notice to all of its members, indicating that all committees will report on the subjects which have been assigned to them and that discussions will be conducted in the same way as at their regular conventions. The International Railway General Foremen's Association announces that reports will be made on the following subjects: (1) Shop practices as applied to repairs of modern power. (2) Methods of measuring shop efficiency. (3) Lubrication of locomotives, cars and their appurtenances. (4) Type of shoes and wedges most successfully used; floating or solid type. (5) Value of safety drives in the mechanical departments.

The International Railway Fuel Association and the Master Boiler Makers Association are working on their programs.

Radical changes in railway operating methods and equipment, the possibility of utilizing improved tools and facilities, and pressing problems involving the personnel, would seem to demand aggressive and constructive study and action on the part of all of the mechanical-department associations. Too much time has already elapsed between their meetings. Interchange of experiences and joint consideration and study of important problems affecting better service, and operating efficiency and economy are vital in the best interests of the railroads. It will be a grave mistake if this opportunity is allowed to pass.

The Enginehouse Foreman

"With an engine off the track on the turntable while the movement was very rushing, and at the same time expecting the federal inspectors to show up at any hour; with the force cut down 50 per cent, and the material allowance cut down 85 per cent, this causes you to rob Peter to pay Paul———. * * * * * I have gone days without seeing my children, only when looking down upon them while they were asleep in their beds; all this because of spending such long hours in the roundhouse."

Thus reads part of a letter from an enginehouse foreman; a letter typical of several which we have received in reference to the article, "Roundhouse Foreman's Daily Log," published in the *Railway Mechanical Engineer* for May.

Minimizing Failures of Locomotive Axles

Failures of locomotive axles, while not frequent, may nevertheless result in considerable damage or even in a disastrous wreck. These failures, it has been observed, usually occur in the wheel fit portion a short distance from the inside face of the wheel hub. In this connection signs of rust have often been observed at this point which indicate a slippage or movement between the surface of the axle and the bore of the wheel hub. Due to the location which renders inspection extremely difficult it is rarely possible to detect incipient cracks and remove the axle before a fracture occurs. The puzzling feature of the situation has been the fact that an analysis by accepted formulas has shown stresses to be well within the elastic limit of the axle material.

The repeated occurrence of such failures was evidence that there must be certain stresses set up in the axle the cause of which had not been determined. In order to ascertain the reason, if possible, a carefully conceived and well-conducted investigation was carried out as outlined in an article in the April issue of the *Railway Mechanical Engineer*. The investigation included photo-elastic studies of combined stresses due to wheel-press fits and axle flexure under load, together with fatigue tests. Information obtained indicated with great clearness where several modifications might be made in the design which would add materially to the axle life and by a reduction of stress concentration permit of the utilization of practically the full elastic strength of the axle.

The changes found to be necessary were: Elimination

of the shoulder next to the wheel hub; the adoption of an increased diameter for the wheel fit; and the grooving of the wheel hub on the inside to obtain a flexibility of the hub which would result in a decrease in concentrated axle stresses. These improvements, while applicable primarily to outboard-bearing axles of trailing, engine and tender trucks of steam locomotives and to certain axles of electric and internal-combustion locomotives, are also at least partially applicable to driving axles and engine-truck axles, with inboard bearings, as well as to crank pins. The research, moreover, would indicate that the A.R.A. standards for freight- and passenger-car truck axles might be revised with advantage. Another change advisable in car wheels is the adoption of the hub groove.

Skilled Workers Needed

"Skilled machine workers are at a premium now." This clause is quoted from an article on the front page of a newspaper published in an industrial city of the East. The statement that "more than one hundred jobs went begging during the day," appears in the same article. It is true that thousands of people are still on relief rolls in that city, although many have been dropped in recent weeks. The difficulty apparently is that they are not skilled for machine work or shop operations of the type required.

Thoughtful railroad mechanical department officers have been expressing concern at what may happen when they attempt to rebuild their shop forces. Some roads are beginning to add apprentices in the effort to prepare for the future. The Federal Committee on Apprentice Training, in the opening paragraphs of its bulletin No. 1, entitled, "What the Federal-State Apprentice Training Program Means to Employers," issued April, 1935, gives four reasons for an impending scarcity of thoroughly trained labor. There has been a moratorium on training during the depression. Immigration from Europe, one of our chief sources of skilled labor, has been cut off. The length of the working day in industry has been shortened. New machinery, new processes and new methods introduced since 1929 have caused the obsolescence of skilled workers.

Freight car loadings in recent weeks have not averaged more than those of the same time a year ago. The general belief, however, seems to be that we are on the way up and out of the depths of the depression. When things do really start to move the railroads will have a real job on their hands. It is high time to get the shop organization and equipment in shape for a recovery, which apparently cannot much longer be delayed, even though the politicians continue to meddle and interfere with economic forces which they do not understand and which they cannot intelligently control.

Why Carry the Burden Of Obsolete Facilities?

During the past five years the railroads of this country have, through force of necessity, been operating under a policy involving severe retrenchment in the purchase of equipment which contributes to the improvement of property. During that time the industries which manufacture equipment used on railroads have devoted much of their time to the development of new ideas which are now available and ready to help effect the economies the railroads must make to assure profitable operation. The fact that the roads have been reluctant to make expenditures for property improvement has given rise to the feeling in some quarters that railroad management is not progressive and that it has no desire to take advantage of modern improvements in order to cut costs. Those who are in close contact with railroad problems and know by experience that there are many obstacles which tend to restrict that freedom of action so common in some other industries do not share that feeling.

Of all the problems in railroading there is none of greater magnitude, when viewed from the standpoint of operating expenditures, than that involved in the maintenance of equipment. Twenty-seven per cent of the money spent for operation is spent for this purpose and in normal times this represents an average of approximately 400 million dollars a year. The facilities used for the maintenance of equipment represent an investment of one billion dollars of which 320 million is in shop machinery, a large part of which investment is admittedly obsolete both from the standpoint of age and of productive capacity.

In any consideration of a question of such magnitude and importance as that of equipment maintenance it is worth while to keep clearly in mind the fact that, as rail traffic increases, the unit costs of equipment repairs will probably increase disproportionately unless management takes steps to control that tendency by taking advantage of modern methods and equipment to effect economies. The question naturally arises as to the direction in which efforts should be directed to bring this about. It is fortunate that, during the past five years, a great deal of thought and careful study has been given to the question and that we are much better equipped to provide an answer than we were five years ago. Studies made by various agencies indicate that substantial economies may be effected in equipment maintenance by the introduction of modern motive power to replace obsolete power, which can be operated under any condition only at greater cost than is justified, and in the replacement of obsolete and inadequate shop facilities. These are two phases of the problem which must be considered jointly for to introduce modern motive power without also making the necessary improvements to repair facilities would only result in preventing the roads from enjoying all of the savings they have a right to expect. On the other hand the importance of improving shop facilities can best be

appreciated when it is considered that such improvements begin to return savings on the investment immediately they are installed and, as new motive power is introduced, it can be done with the confidence that a threefold objective has been reached—reduced repair costs as a result of modern design; reduced costs of operation on the road and the lowest possible repair costs when the locomotive comes to the enginehouse and the back shop.

That shops and enginehouses have not been given the consideration by management they seem to deserve is indicated by the fact that less than four per cent of all the money spent for additions and betterments on the Class I roads over a period of 17.5 years prior to 1932 was spent for improving the facilities which the industry uses to maintain equipment the cost of which maintenance represented 27 per cent of all operating expenses.

A review of the foregoing facts seems to point quite clearly to the need of a definite policy in relation to motive power and equipment—one which will assure the systematic replacement of obsolete locomotives and cars and obsolete repair facilities over a period of years in order ultimately to arrive at a point where the average age of equipment is materially reduced and where reduced maintenance costs may be enjoyed as a result of improvements in equipment, repair facilities and methods. The establishment of such a policy can best be brought about by an intensive study of the mechanical and operating problems of individual roads.

Can New Shop Tools Be Justified?

There are those who are of the opinion that one of the reasons why machine tools in the railroad field have been continued in service, in many cases far beyond the end of their economic life, is that the long-established policies in relation to depreciation have not been sound and that had the roads, like some other industries, set up adequate depreciation there would have been a reserve out of which to purchase new tools. Three facts in this connection are important: (1) Accounting practices employed by the railroads are not of their own choice but are established by the Interstate Commerce Commission; (2) The I. C. C. has already ordered the roads to change over from retirement to depreciation accounting and (3) regardless of accounting methods, should a cash reserve be set up that portion of the reserve fund established as a result of shop machinery depreciation would not, in all likelihood, be earmarked for machinery purchases but would be thrown into a fund which would be spent for those improvements which would return the greatest saving on the investment. If this be true it is evident that the only justification for the purchase of new machine tools is that by their increased productive capacity and lower machine maintenance costs they will return as great or a greater percentage on the investment than any other equipment that could be purchased.

Studies which have been made in this and other industries leave no doubt that modern machines, as compared with those 20, 30 or even 40 years old, can not only effect substantial economies but can in many instances pay for themselves in a relatively short period of time. These columns, during the past two years, have included many articles which have indicated the savings that might be made and have ventured suggestions to the effect that, even during depression years when capital investments have been sharply curtailed, it would be worth while for mechanical officers to investigate the potentialities of profiting by installing improved machine equipment through greater producing capacity or, at least consider that such installations would cut down the operating losses by reducing machine-tool operating and repair costs.

In presenting this issue the reader's attention is directed to two articles, one entitled "Railway Equipment Maintenance" on page 217 and the other entitled "Locomotive Maintenance Facilities at Oelwein Improved" on page 220. The first of these articles records some most interesting statistics relating to the question of equipment maintenance and in its conclusion the author pertinently states, among other things, that "There can be no great increase in the spread between income and expense until management as a whole is able to recognize the superior results accomplished by outstanding methods and facilities and can arrange its organization in such a manner that the entire industry may profit therefrom," and that "Economical maintenance of equipment, continuing over long periods of time, can be attained only by adopting a consistent policy of management, beginning with the careful design of equipment in every way suitable for the conditions under which it must operate. Management must then provide suitable repair-shop facilities equipped with the best machinery obtainable, together with a personnel properly organized and intelligently directed so that the service life of equipment may be restored currently as required by the traffic handled."

The second article, dealing with the rehabilitation of shop facilities on the Chicago Great Western is the story of what one railroad mechanical department has actually done to assure itself of minimum locomotive repair costs—an accomplishment that involved the rearrangement of facilities; the retiring of 135 obsolete machine tools, most of which were over 35 years old, and the installation of 48 modern machines to take their place. The results, which are recorded in the article, speak for themselves both as to increased productive capacity and the ability to perform a better job in considerably less time.

Every mechanical officer owes it to his company to give serious thought to the importance of reducing equipment maintenance expenditures. Such a reduction can best be brought about by an intensive study of the conditions surrounding his operation and where it is discovered that obsolete facilities stand in the way of improvement he can adopt a policy of equipment replacement with the confidence that improvements in equipment—whether it be locomotives or repair facilities—will assure a satisfactory return on the investment.

THE READER'S PAGE

Sectional Scales For Weighing Locomotives

To the Editor:

The article on page 58 of your February number prompts me to offer some further comments on this subject. One can sympathize with mechanical department officials who have enough responsibilities and troubles now and are reluctant to explore any new avenues. At the same time, it may as well be admitted that if sectional scales were unnecessary, undesirable, and of questionable value except for obtaining the center of gravity of a locomotive, they would never have attained widespread use in other lands, where managements are by no means addicted to useless expenditures.

The difficulty of obtaining consistent figures for the weights on individual wheels appears to be somewhat exaggerated in the letter reproduced on page 58. Incidentally, the reason advanced for this difficulty constitutes a poor recommendation for equalized spring rigging, and the mention of weights that are inconsistent in all respects, etc., reminds one that British engineers have long claimed that the exact weight from time to time on any one axle of an equalized locomotive is highly doubtful. However, equalizers are almost universally used by Continental European railways, and they seem to have little trouble in weighing their engines. Individual axle loads of every type of locomotive in Germany, based on average scale weights, are published in the official "Merkbuch." It may be of interest to quote from the "Instructions for the Handling of Locomotives and Tenders in the Workshops," formerly in effect on the Prussian-Hessian State Railways. I do not know the exact procedure at present prescribed on the Reichsbahn, but it probably closely follows the former Prussian practice.

"Immediately before weighing, all springs, as well as guides and bolts of spring hangers, are to be well pounded, in order to remove as far as possible any change in the axle-loads caused by frictional resistance.

"For the determination of axle-loads in working order, the following are to be assumed: for the enginemen, 330 lb.; coal bunkers and water tanks filled, 10.2 lb. of coal on each sq. ft. of grate area; 165 lb. of sand in each sandbox; a water level of 4 in. above the crown sheet in cold boilers, or a level of 6 in. in hot boilers at the authorized working pressure; and equipment of the locomotive with all accessories in their regular places of storage. Two-cylinder locomotives are to be weighed once with the right crank in a position 45 degrees above the forward dead center, and once with the same crank 45 degrees below the back dead center. The average of these two weighings gives the weight sought."

With some of the statements on page 58, there will be general agreement. Certainly, no one would recommend placing individual wheel scales at the disposal of shop and road forces *indiscriminately*. Adjusting locomotive wheel-loads is not a job to be entrusted to any handyman about the shop or roundhouse. Experience and judgment are required, since tampering with the load on any one wheel immediately affects the load on every other wheel of the engine. Also, the danger of unauthorized experimenting with weight distribution must be kept in mind. Perhaps the continued success of sectional scales and adjustable spring rigging in European practice may be partly ascribed to the rigid discipline said to be imposed on the shop and engine men.

There can be no doubt that a "set of individual locomotive scales located at the designing headquarters of each railway that can afford them would be very desirable." If an elaborate set of weighing equipment, consisting of a scale with 14 separate tables, is considered a prime necessity in the central workshops of a metre-gage railway in Nigeria, for instance, how much more requisite must it be in the United States where wheel-loads are much higher in relation to weight of rail. The high cost of a complete sectional scale is probably the most effective argument against it. To meet this objection, foreign firms with long experience in the manufacture of locomotive weighing apparatus have perfected several types of portable weighing machines, which serve the purpose very well. In determining the static weight of locomotive engines, it is scarcely essential to work to such fine limits as "plus or minus 20 lb." Greater variations than this may be recorded, according as the enginemen may be fat or lean.

What many motive power officials fail to recognize, or refuse to admit, is the possibility that the wheel-loads of their engines may be, not hundreds, but thousands of pounds above or below the specified weights. Whether this be due to faulty design, slipshod maintenance, or other causes, it is not an ideal condition and nothing is gained by closing one's eyes to it. Some American engineers are entirely satisfied if the center of gravity of a locomotive is in the correct position, their assumption then being that the weight distribution is bound to be approximately correct. Theoretically, each locomotive has a certain definite weight at the rail under each wheel. Practically, in every locomotive with more than two axles, there are ways of varying that weight within wide limits, without changing the center of gravity.

While diagrams of foreign locomotives, showing individual axle-loads as ascertained by weighing, may be found by the hundred, there is a remarkable lack of similar published information relating to American locomotives. In searching for such data, the writer came across the following figures which, though pertaining to an engine of 30 years ago, are most illuminating:

Type 2-10-2

	Weight in lb.
Leading truck	25,860
First drivers	53,110
Second drivers	58,100
Third drivers	45,760
Fourth drivers	36,110
Fifth drivers	40,680
Trailing truck	26,120

It will perhaps be agreed that the carrying gear of this engine was in need of some intelligent manipulation, and I believe that more drastic treatment than jarring would be necessary to make those scale readings agree with the theoretically correct weights. Dis-

crepancies of 22,000 lb. cannot be charged entirely to friction within the spring rigging.

Coming a little closer to the present time, a diagram presumably based on scale weights, shows the following driving axle-loads for the USRA light 2-10-2 type locomotives:

	Lb.
First drivers	51,000
Second drivers	51,500
Third drivers	59,100
Fourth drivers	56,500
Fifth drivers	55,900

A difference of 8,100 lb. between the loads on the 1st and 3rd pairs of drivers could hardly be considered negligible. Nevertheless, differences of 5,000 to 10,000 lb. and more among various driving axle-loads, though they are not conducive to low maintenance costs, are not the most important phase of the problem. As observed by Mr. Raitt on page 59, more serious consequences are caused by the shifting of weight from driving wheels to leading and trailing trucks, which seems to be a common ailment of modern locomotives. The results are loss of adhesion, hot boxes on the truck axles, increased resistance to curving, and rough riding of the engines. As a final example, let me cite the case of some recent foreign-built heavy engines of typical American design. These were new engines with full-sized tires on every wheel. The figures will speak for themselves:

	Builder's specification	As weighed by railroad after being thoroughly broken in	As finally adjusted
Leading truck	48,000 lb.	67,000 lb.	53,500 lb.
Drivers	204,000 lb.	160,000 lb.	199,500 lb.
Trailing truck	50,000 lb.	75,000 lb.	49,000 lb.
	302,000 lb.	302,000 lb.	302,000 lb.

WM. T. HOECKER.

Creeping Reverse Gears

TO THE EDITOR:

I should like to comment on the editorial "Creeping Reverse Gears," which was published in the September, 1934, *Railway Mechanical Engineer,* page 329, and the communication entitled, "The Problem of Reverse Gear Creep Must Be Solved," on page 63 of the February, 1935, issue.

I have had to do with reverse gears for 30 years and want to say that the authors of these two articles have brought out more real facts regarding them than I have yet heard any one individual express. Indeed, this is a subject very few people are capable of discussing.

In the first place, the average machinist knows very little about the reverse gear and apparently is not interested in studying it. As a result, the railroads pay dear for their "whistle." Some engineers are satisfied as long as the gear will reverse. If they cannot work the engine in close cut-off, because of the gear creeping back and cutting out entirely, the engineer lets his lever down a couple of notches. The engine then exhausts too hard and cuts the fire too heavy. This may affect the speed and if the engineer tries to put it back in close cut-off, it repeats the performance. Tired of jockeying about in this way, he allows the lever to stay down a couple of notches and, figuratively speaking, lets the engine run "with the bridle off." Even then it would not be so bad if the reverse gear would stay where he put it, but it will not and continues to work up and down as much as three-quarters of an inch, and sometimes an inch.

As a result, more fuel is burned and the engineer turns in a report, "Reverse gear creeping. Won't hold." The machinist in the enginehouse examines the cup leathers in the reverse gear cylinder. He finds that they are not in bad shape, but decides to renew them at a cost of around $4.00 for the new material, and possibly more. Then he decides that the piston rod needs turning and that the piston rod packing is leaking. It is an additional expense to turn the rod and replace it, let us say, 75 cents. A new set of piston rod packing will cost another $1.00 or $1.50. Finally he decides to face the valve. It will cost $5.00 or $6.00 to remove the chest, face the valve and replace it. After all this work and expense, the engine is quite likely to come in from the next trip with the same report—"Reverse gear creeping. Won't hold."

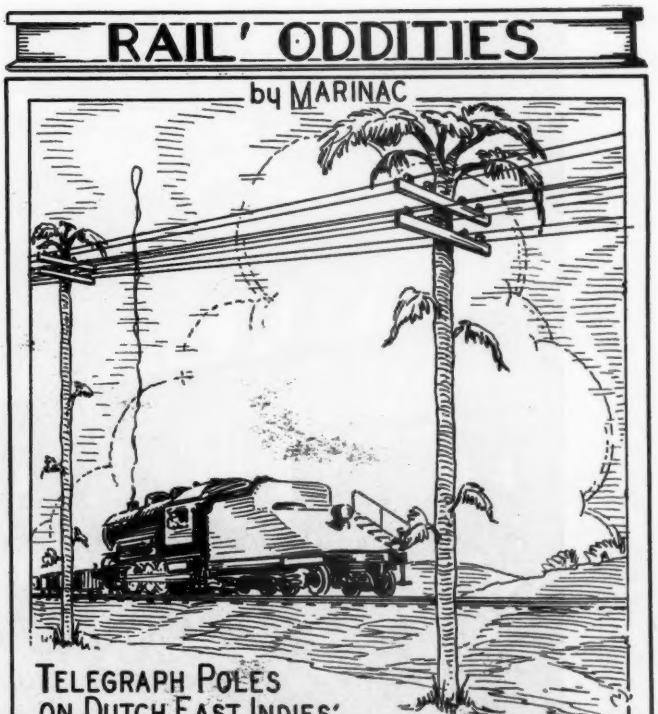
What are we going to do about it? Shall we spend more time looking for something that we don't know about? In a terminal with a small force you cannot afford to put a machinist and helper on a reverse gear for the entire eight hours.

The writer thinks he is fairly familiar with all but a few of the gears on the market. I have yet to see one with a slide valve or rotary valve that does not creep, "Believe It Or Not." The two articles that you have published should be read and re-read by all mechanical operating officers, as well as the machinist who repairs the gears.

FOREMAN LOCOMOTIVE DEPARTMENT.

RAILWAY PAY CHECKS.—I. G. Hull, Atchison, Topeka & Santa Fe agent at Hulah, Okla., settles all claims as to the smallest railway pay check. He owns Santa Fe check No. 54151 R. R. dated July 1, 1934, in the amount of one cent. They don't come any smaller than that.

* * *



Further explanation furnished by the Editor upon request

With the
Car Foremen and Inspectors

Passenger Truck Work On the Illinois Central

A FEATURE of the extensive passenger-car reconditioning program carried out by the Illinois Central during the past year was the attention given to truck repairs. All trucks on general repair cars were completely dismantled and every part sandblasted or otherwise cleaned, inspected for defects and repaired or renewed, as necessary, so that when re-assembled, the trucks were in condition to give reliable service over an extended period of time. Ex-Cell-O casehardened steel pins and bushings were applied throughout in all motion parts to assure long wear and freedom from slack action. All pedestal and bolster bearing surfaces were provided with special wear-resisting steel plates.

Particular attention was paid to the squaring of the truck frames to avoid any possibility of flange cutting. Equalizer bearing surfaces were built up by welding and remachined. Coil and elliptic springs were carefully checked and dipped in a No-Oxide bath to prevent rusting and assure easy spring action. Pullmanite journal boxes, Magnus brass and coil spring packing were applied. An unusual precaution in the interests of maximum smoothness of truck and car operation was the careful counter-balancing of all wheel assemblies, thus preventing the development of hammer blows which are otherwise transmitted through the truck spring suspension to the car body.

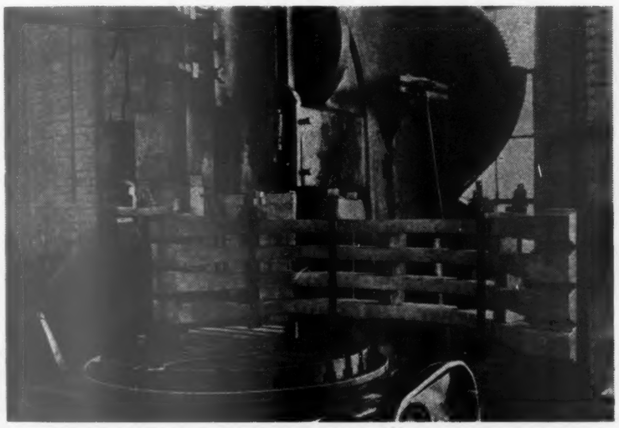
The trucks for Illinois Central passenger coaches, lounge, buffet, parlor and dining cars are given heavy repairs at the Burnside (Ill.) shops, this work being concentrated in one section of a shop which is served by a 10-ton electric traveling crane and provided with necessary machine equipment, including engine lathes, a slotter, a shaper and a 10-ton bushing press. The blacksmith department with all necessary forging and heat-treating equipment is located in the bay adjacent to the truck work, an arrangement which saves considerable trucking time and labor in handling truck parts to and from the blacksmith shop.

The passenger trucks to be repaired consist, generally speaking, of the integral cast steel type with straight equalizers and the earlier type of cast steel truck frame with bolted pedestals and underhung equalizers. As soon as a pair of car trucks are removed in the shop, they are rolled out to the sandblast station and thor-

Truck repair department at Burnside passenger-car shop of the Illinois Central

Below—Passenger-truck equalizers machined in groups of four on a 24-in. slotter

Above—Truck repair department at Burnside passenger-car shop of the Illinois Central



oughly cleaned by sandblasting, then being returned to the shop and completely dismantled. The frames are mounted on substantial three-leg horses, the wheels and axles being sent to the wheel shop and various other truck parts sent to their respective shop departments for necessary reconditioning work. Referring to the illustration, which shows two truck frames mounted on the special horses in the truck shop, the well-braced construction of these horses will be noticed; also the provision of steel bands around the heavy oak blocks which form the tops of the horses and make large and substantial bearing surfaces for the truck frames.

After sandblasting, the truck frames are thoroughly inspected for cracks at all fillets, corners and parts subject to breakage. The next operation is to square the truck frames, which is done using the same kind of trams, gages and general method as in squaring locomotive shoes and wedges. By this means, pedestal bearing surfaces are located square with the center line of the truck frame, bolt holes being plugged and redrilled, if necessary, to accomplish this purpose. As stated, casehardened steel liners are applied to the pedestals. Brake rigging hanger suspension holes are reamed and casehardened steel bushings applied.

All truck motion parts are sandblasted and inspected carefully for cracks. Worn holes in the brake and spring rigging are filled by the electric welding process, new holes being drilled to standard spacing and .004 in. smaller in diameter than the hardened steel bushings which are subsequently applied by the use of the 50-ton press shown in one of the illustrations. All brake and spring rigging parts are normalized after welding, but before the application of the hardened bushings. The brake and spring hanger pins used in these bushings are also of the Ex-Cell-O type, being machined to close tolerances from a uniformly high quality of steel which is casehardened to a predetermined depth and designed to give unusually good wearing properties. One of the illustrations shows a miscellaneous group of hardened steel pins and bushings used in various truck parts.

Particular care is exercised in reconditioning the truck equalizers. All equalizers are sandblasted and thoroughly inspected for cracks or possible defects. Equalizer bearing surfaces are built up where worn by welding to about 1/8 in. above standard blue-print size, the equalizers then being normalized and the bearing surfaces accurately machined to the original dimensions.

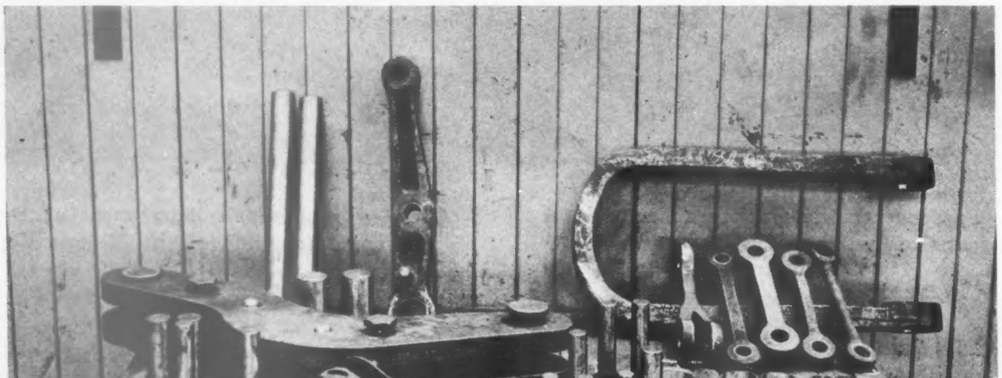
The first operation in machining these equalizers is to square and clamp four of them as a unit on the table of a 24-in. slotter, as shown in one of the illustrations. A roughing cut is then taken over the bearing surfaces, using a 1/8-in. feed. A smooth finishing cut is made with a square-nose tool, no scratches being permitted to remain in the face of the equalizers or at the fillets. The equalizer ends are machined on a shaper; also the sides. About eight equalizers can be machined, floor to floor, in seven hours, using this method.

After machining, the equalizers are placed, two at a time, on three parallel pedestals, mounted on a face plate, as shown in one of the illustrations. In this position, they are checked for squareness in both directions and for a full contact on the horizontal bearing surfaces. Referring to the illustration, it will be noted that one-half round slots have been machined in the

equalizer bearing surfaces to accommodate the ribs on the journal boxes and thus hold the equalizers in the proper position, in spite of the disturbing vibration and shocks encountered in service. The amount of equalizer offset, as well as length, is checked while the equalizers are on this surface plate so as to make sure that, when assembled in the truck frame, all parts will fit accurately. The equalizers illustrated are of the underhung type but straight-bearing equalizers also are checked on this surface plate.

Bolsters are sandblasted and inspected for defects, worn surfaces being built up by the acetylene welding process and spring seats machined square on a shaper. Due care is exercised to provide the necessary clearance for normal spring action and rocking. The bolsters and side bearing surfaces, as well as those on the truck frame, are equipped with special wear-resisting steel plates. Worn truck center plates are built up by oxy-acetylene welding and re-machined to standard dimensions on an engine lathe.

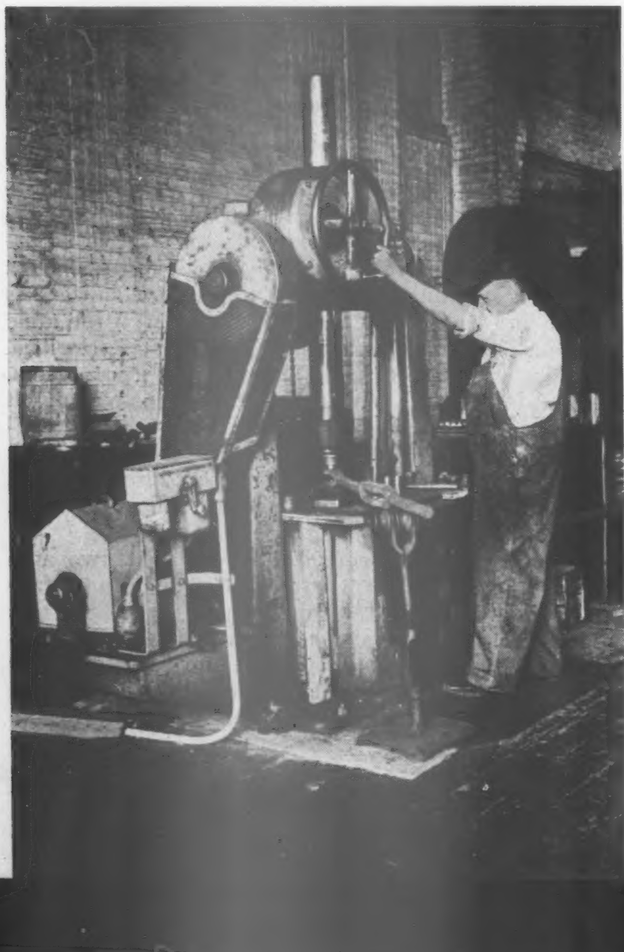
Springs are sandblasted, inspected and, if in suitable condition for further service, dipped in a vat of No-Oxide to give a lubricating and rust-preventive coating. Defective springs are replaced with new or repaired springs. Temporary calibrated springs are applied in the trucks whenever there is any question regarding the proper spring capacity required for a given car. This is usually done as a check on one car of each series to make sure that the proper spring capacity is being obtained. Brake beam ends are built up by the electric welding process, the ends turned and new bushings applied. Brake heads are reamed out and bushings applied.



Above—Miscellaneous spring and brake rigging parts equipped with Excello hardened steel pins and bushings

View shows swing hanger, brake hanger, truck lever connection, balance hangers and pins, lever connections and pins, brake head, truck lever, brake-beam fulcrum, lever bushings, pull-rod bushings, lever connection bushing, brake-beam bushings, miscellaneous pins, balance hanger bushing and adjusting rod bushing.

Below—Lucas 50-ton press used in applying hardened steel bushings in brake and spring rigging



Above—Truck frames mounted on horses ready for squaring and other repair work

Wheels and axles are reconditioned in the wheel shop in accordance with the usual procedure. The wheels applied to all lounge, buffet, dining and parlor cars are counterbalanced to assure easy riding. The method of counterbalancing consists of trying each set of mounted wheels with the journals resting on a pair of level, horizontal steel bars. If out of balance, the wheels are placed in the wheel lathe and excess metal turned off the hub, as necessary, to make the wheels balance. This particular detail in reconditioning passenger-car trucks, which is often overlooked, contributes to a rough riding truck and car, particularly at modern high operating speeds.

All of the operations in repairing passenger-car trucks at Burnside shops are done by experienced truck shop men under sufficiently close supervision to assure the desired results as to quality and permanence of the work.

Hand Brake Chain Connection

A NEW and more economical form of hand-brake chain connection to the hand-brake rod, known as the Apex hand brake chain adjuster, has recently been placed on the market by Apex Railway Devices, 310 S. Michigan avenue, Chicago. This adjuster, made of malleable iron, is 7½ in. long, 3$^1/_{16}$ in. wide at the

Close-up view of the Apex hand brake chain adjuster

mouth, and 1$^5/_{16}$ in. at the lips of the jaw. The link inside the jaw rests on a ledge and is secured from dislodgement by a ½-in. bolt passing above it, as illustrated. There is no strain on the bolt, for the center line of pull on the jaw is well below the bolt. In addition, the jaw is reinforced at that point taking the stress by a strap passing across the lower portion. The strength of the connection is said to be nine times greater than the safe working load of the brake chain.

The Apex adjuster is designed to furnish an economical medium for maintaining the proper brake chain length throughout the life of a freight car.

Apex chain adjusters are manufactured in six different types to fit all applications on new or existing equipment.

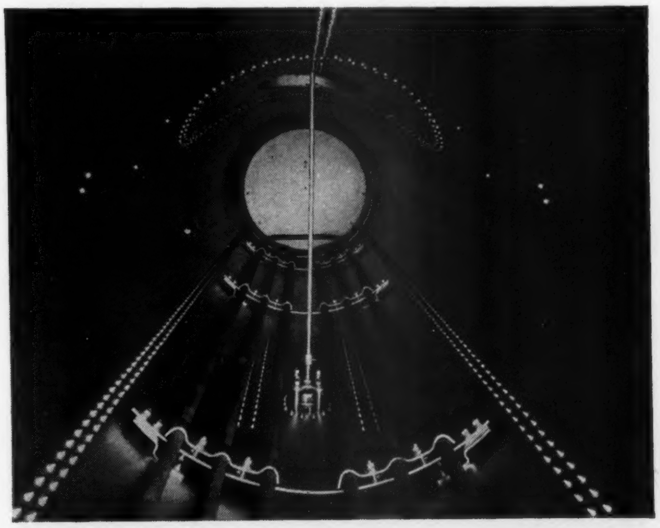
Boring Tools and Cutters

TWO products recently placed on the market by the Davis Boring Tool Co., St. Louis, Mo., are especially designed for use in connection with the machining of car wheels. The Davis expansion boring tool shown in the illustration is used for rough and finish boring and chamfering car wheels in one operation. The feature of this tool is a four-cutter micrometer expansion unit for the roughing operation instead of the usual two-cutter unit which is used in other styles of the Davis expansion car-wheel boring tools. Stellite is welded to the tool body in front of the roughing cutters, thus preventing excessive chip wear and prolonging the life of the tool. These boring tools can be furnished with high-speed steel, Stellite or tungsten-carbide-tipped cutters.

The Davis Super cutters are a development brought about by the necessity of providing improved cutting

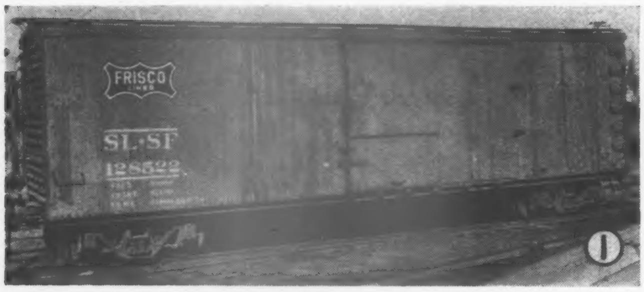
Davis four-cutter Two-in-One car wheel boring tool

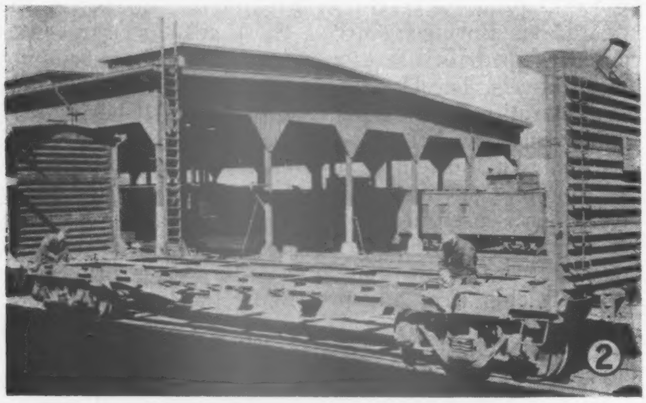
tools for the rough and finish boring of the heat-treated steel wheels. These cutters are made of a grade of high-speed steel selected as a result of numerous tests by the Davis research department. They are scientifically ground and heat treated for uniform structure and hardness.

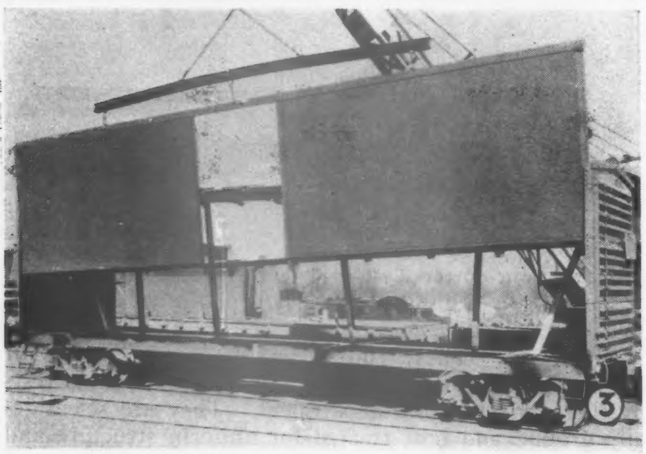


The heating coils in the bottom of each tank were fabricated by welding 2-in. extra heavy genuine wrought-iron pipe. A total of 14,400 ft. of such pipe was required for the 75 cars.

Interior of one of 75 syrup tank cars built in the fall of 1934 by the General American Transportation Corporation for the Crystal Car Lines, a subsidiary of the Corn Products Refining Company, Sharon, Pa.







Frisco Rebuilds Box and Gondola Cars

ONE of the outstanding projects in the extensive car rehabilitation program planned by the St. Louis-San Francisco for completion during the present year is the rebuilding of 600 wooden box cars into steel cars at an approximate cost of $750,000; also the rebuilding and application of steel sides to 150 Frisco 50-ton gondola cars. The box-car work is being done at the North Springfield (Mo.) car repair yard and the gondola-car work at Yale, Tenn., a modern progressive system of repairs being followed at each place.

The double-sheathed wood box cars, when received at the car repair yard at North Springfield, are placed at the first position where all wood is removed. At the second position, the underframe and steel ends are thoroughly inspected and necessary repairs or renewals made. Steel work is then given a thorough cleaning by sandblasting and all rust and scale removed preparatory to painting. The trucks are inspected and repaired, new wheels being applied when necessary. After the underframe, trucks and steel ends are painted, Youngstown steel sides are placed in position and corrugated steel doors, supplied by the same manufacturer and equipped with Union duplex door fixtures, are applied; also, safety appliances. A decking gang then applies the wood floor stringers at the doorways and the wood floor, the latter being secured with Grip Nut Leak-proof bolts.

The inside lining is then applied to the car sides and ends, extending up to the side plate. The Hutchins outside metal roof is applied, running boards put in place and the cars moved to the final position where they are painted, stenciled and weighed. The cars are equipped with Symington swivel-butt couplers, Ajax hand brakes and Miner friction bolster springs, the latter being designed especially to provide easy riding at modern high operating speeds. The outside metal roof is laid over a wooden sub-roof which prevents moisture from forming on the underside and makes these cars particularly desirable for such high-class lading as flour, cereals, etc.

The cars are moved from one position to another by means of an air-operated winch. Various jacks, safety platforms and devices are used to assure safety, speed of operation and convenience for workmen. The schedule calls for completion of 50 cars a month. The cars are repaired in units of two cars at each position, requiring a grand total of 564 man-hours, or 282 man-hours per car. The detailed operations performed at each position, together with the man-hours for each double-car unit, are as follows:

Station 1.—Each car is moved to the stripping track where all wood from the body, including floor and roof, is removed. The above operation requires the time of four third-class car men, eight hours each, and two laborers, eight hours each. Total, 48 man-hr.

Station 2.—The work at this station includes cutting off all old rivets from defective parts to be removed from the steel framing and straightening the steel ends,

(1) Frisco box car as received for rebuilding at North Springfield (Mo.) shops (2) Car at Station 3 for refitting steel parts and redriving underframe rivets (3) One of the new steel car sides being lowered into position at Station 6 (4) Car ready for movement to Station 7 where the decking gang applies floors (5) Steel box car at Station 10, painted, stenciled and ready for service

operations which require two first-class car men eight hours each, and two second-class car men eight hours each. Total, 32 man-hr.

Station 3.—At this station, the steel framing is fitted up and riveted, requiring the services of eight first-class car men as fit-up men and four first-class, one second-class and one third-class car men, each for eight hours, as driving gang. Total, 112 man-hr.

Station 4.—The car is now ready for the sandblasting gang. All metal parts, including the steel underframe, are given a thorough cleaning, this work being performed by one third-class painter and one laborer, eight hours each. Total, 16 man-hr.

Station 5.—The car is next moved to this station where the trucks are gone over, repaired and wheels applied when necessary. All brake rigging is overhauled or renewed. The car is painted, that is, the steel underframe, trucks and steel framing. The operations mentioned require the time of one first-class car man six hours, one second-class car man six hours, one brake rigging man four hours and a second-class painter four hours. Total, 20 man-hr.

Station 6.—The car is now ready for the application of steel sides, drilling and driving up. This requires a Brownhoist crew four man-hours, six first-class fit-up men 48 man-hours, four first-class drive-up men 32 man-hours, and two second-class drive-up men 16 man-hours. Necessary welding is also done here, requiring two welders 14 man-hours. Total, 114 man-hr.

Station 7.—The decking gang is next in line for the application of the flooring and deck supports, which requires three first-class men eight hours each. Total, 24 man-hr.

Station 8.—The next operation is applying the interior framing and inside lining which requires three first-class men eight hours each. Total, 24 man-hr.

Station 9.—The roofs and running boards are applied at this station, requiring two first-class and one second-class car men eight hours each. Total, 24 man-hr.

Station 10.—The car is now painted and stenciled, which completes the various operations. This work requires one first-class and two second-class painters. Total, 14 man-hr.

Miscellaneous

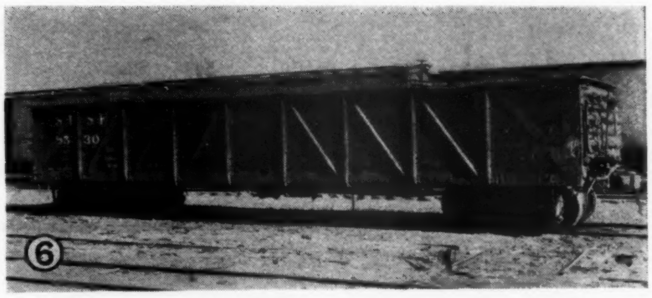
Item 1.—Making and reconditioning of steel parts: Two blacksmiths, first-class, 14 man-hours; one boilermaker, first-class, 4 man-hours; two boilermakers, third-class, 14 man-hours; one boilermaker, third-class, 8 man-hours. Total, 40 man-hr.

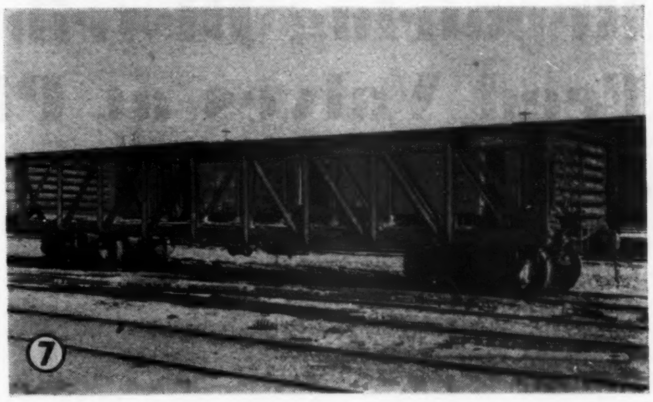
Item 2.—In carrying on the various operations listed above, a great deal of miscellaneous work is necessary, which cannot be charged to the individual operation, such as time of supplymen, laborers and mill workers. Total, 96 man-hr.

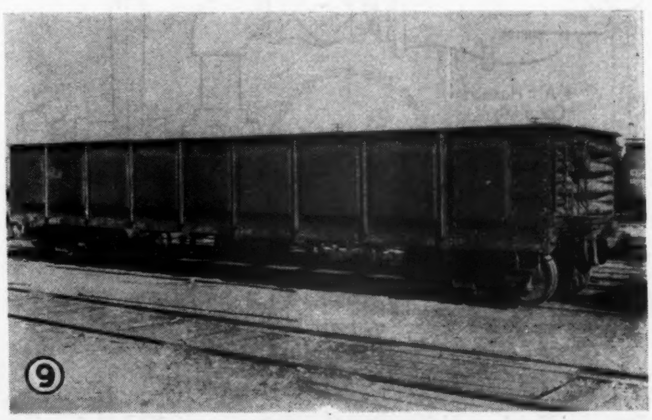
Grand total man-hours for two cars, 564 hr.

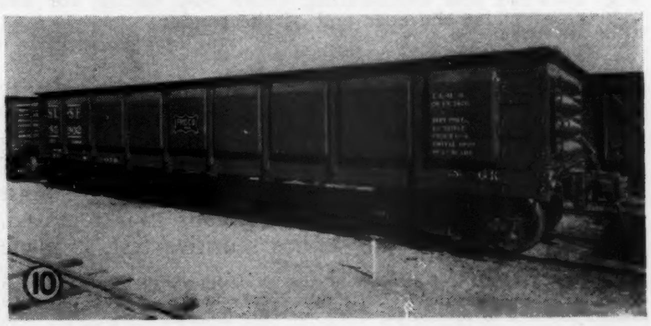
Average man-hours per car, 282 hr.

Work on the 50-ton gondola cars is being done, as mentioned, at Yale, Tenn., where a progressive system of repairs similar to that described for the box cars is being followed.









(6) Frisco 50-ton gondola as received for rebuilding at Yale (Tenn.) shops (7) Gondola with wood side planking removed, ready for steel strippers (8) Skeleton underframe ready for application of a new all-steel superstructure (9) Gondola after application of new steel parts, trucks and safety appliances (10) Completely rebuilt and modernized gondola car, painted ready for service

In the Back Shop and Enginehouse

Repairing Distributing and Feed Valves at Pitcairn*

THE repair work on feed and distributing valves, as on other important air-brake parts, is handled by the Pennsylvania at four central shops on the system —Wilmington, Del.; Altoona, Pa.; Pitcairn, Pa., and Ft. Wayne, Ind. Air-brake parts for the Central Region are repaired at the central air-brake repair shop at Pitcairn. Previous articles have described the facilities of the shop and, in detail, the operations involved in repairing air compressors and triple valves. This article deals with the operations on feed valves and distributing valves.

Distributing Valves

When a distributing valve has been in service six months, or for any reason fails to function properly it is removed from the locomotive and forwarded to the central shop for repairs. Before a distributing valve is removed from a locomotive it is tested with a device, shown in Fig. 1, which is attached to the air-brake hose

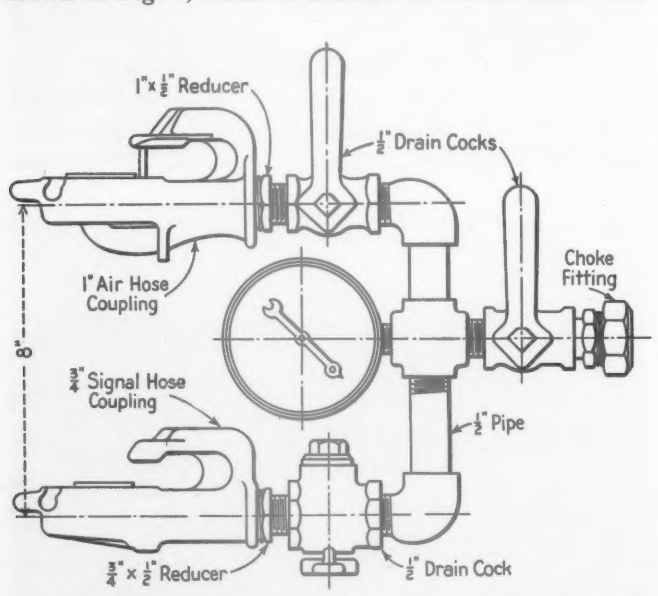


Fig. 1—Feed and distributing valve test device for use at the rear end of the tender

on the rear end of the tender. With this testing device attached and with the locomotive brake valve in lap position, the air cock leading to the choke fitting having a $\frac{1}{16}$-in. orifice is opened until a 5-lb. reduction of brake-pipe pressure results. The distributing valve must respond to this reduction and if it fails it is removed. This test, known as the service sensitive test, is made each day. In testing distributing valves the signal hose coupling is not used. The other cock is kept closed.

The type of distributing valve handled at Pitcairn is known as the 6E valve and is divided into two classes; namely, plain and quick action, or, to be more explicit,

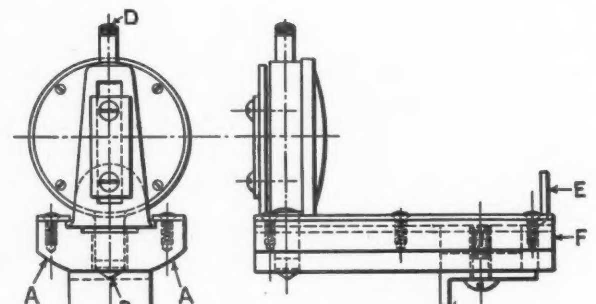


Fig. 2—Dial type cylinder calipering gage

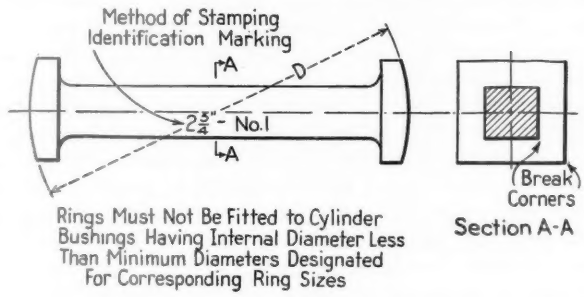
those equipped with plain cylinder caps and those equipped with quick-action caps. Approximately 18 per cent of the distributing valves handled at Pitcairn are of the type equipped with quick-action caps.

Distributing valves are unloaded at Pitcairn from cars from outlying points into steel containers which are moved into the shop by lift trucks. The containers are taken to that section of the shop which is set aside for specialized repair work on distributing valves. The layout of this section can be seen in the drawing of the Pitcairn shop which appears on page 116 of the March issue of the *Railway Mechanical Engineer*. Each valve that comes to the shop is identified by a marker plate which is bolted to the application cylinder cover for the purpose of recording the shop abbreviations, repair marks and the date of the last repairs. Before proceeding with repair operations the valves are separated into two groups, as follows: Those which have been in service less than six months from the time they last received attention and those which have been in service more than six months. As a rule valves which have been in service less than six months are cleaned, lubricated and tested and only such repairs made as may be indicated by a rack test. If the date on the valve marker plate indicates that it has been in service more than six months the valve is dismantled and repairs made to remedy the defects which appear as the result of visual inspection.

During the cleaning operations all internal parts, except gaskets, are cleaned with a turpentine substitute,

*This is the fourth of a series of articles dealing with repair work on air-brake equipment at the P.R.R. Pitcairn air-brake repair shop. Previous articles appeared in the March, April and May issues.

care being taken to remove all foreign deposits from the ports in the various valves and their seats, the ports and passages being blown out with compressed air. All pistons are tested on centers to insure their straightness with a device shown in Fig. 7 on page 202 of the May *Railway Mechanical Engineer*. A pointed piece of wood, similar to a lead pencil, is used to clean the feed grooves and ports, the use of a metal tool being prohibited because of the possibility of enlarging the ports and grooves. Piston packing rings are not removed from

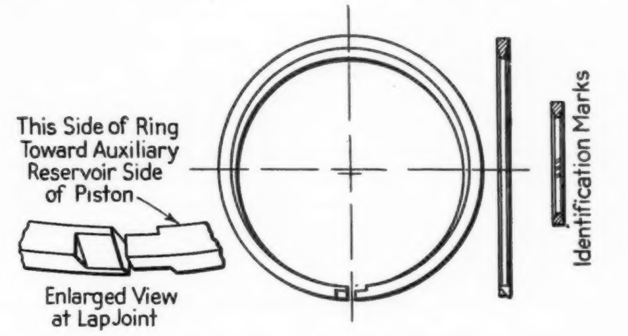


Gage No.	W.A.B. Co. Pc. No.	Nominal Size In.	D Actual Size, In.
1	86,891		3.500
2	86,892		3.504
3	86,893	3½	3.508
4	86,894		3.512
1	88,611		4.000
2	88,612		4.004
3	88,613	4	4.008
4	88,614		4.012

Fig. 3—Gages used for selecting packing rings for distributing valve cylinders

the ring grooves and care is taken not to distort them in any manner unless their renewal is necessary.

The faces of the slide valves and their seats are sparingly coated with a special triple-valve grease. The equalizing piston and its cylinder are lubricated with anti-friction oil. The application piston packing leather is lubricated sparingly with a brake-cylinder compound on the application side of the piston, the lubricant being placed between the expander ring and



W.A.B. Co. Pc. No.	Indentification Mark	Diameter In.	To Fit Cyl. Diam., In.
Equalizing Piston Rings			
85,811	I	3½ + .000	3.496 – 3.500
85,812	II	3½ + .004	3.500 – 3.504
85,813	III	3½ + .008	3.504 – 3.508
85,814	IIII	3½ + .012	3.508 – 3.512
Application Piston Rings			
87,017	I	4 + .000	3.996 – 4.000
87,018	II	4 + .004	4.000 – 4.004
87,019	III	4 + .008	4.004 – 4.008
87,020	IIII	4 + .012	4.008 – 4.012

Fig. 4—Sketch and table for selecting piston rings for the Type 6-E distributing valve

the packing leather. When the valves are assembled the threaded portions of all cap screws, nuts and plugs are sparingly coated with oil and graphite.

When the cleaning operation has been completed and the valve assembled the workman places his individual identification mark on the marker plate and the valve is delivered to the test rack where tests are made according to a standard test code adopted by the railroad company.

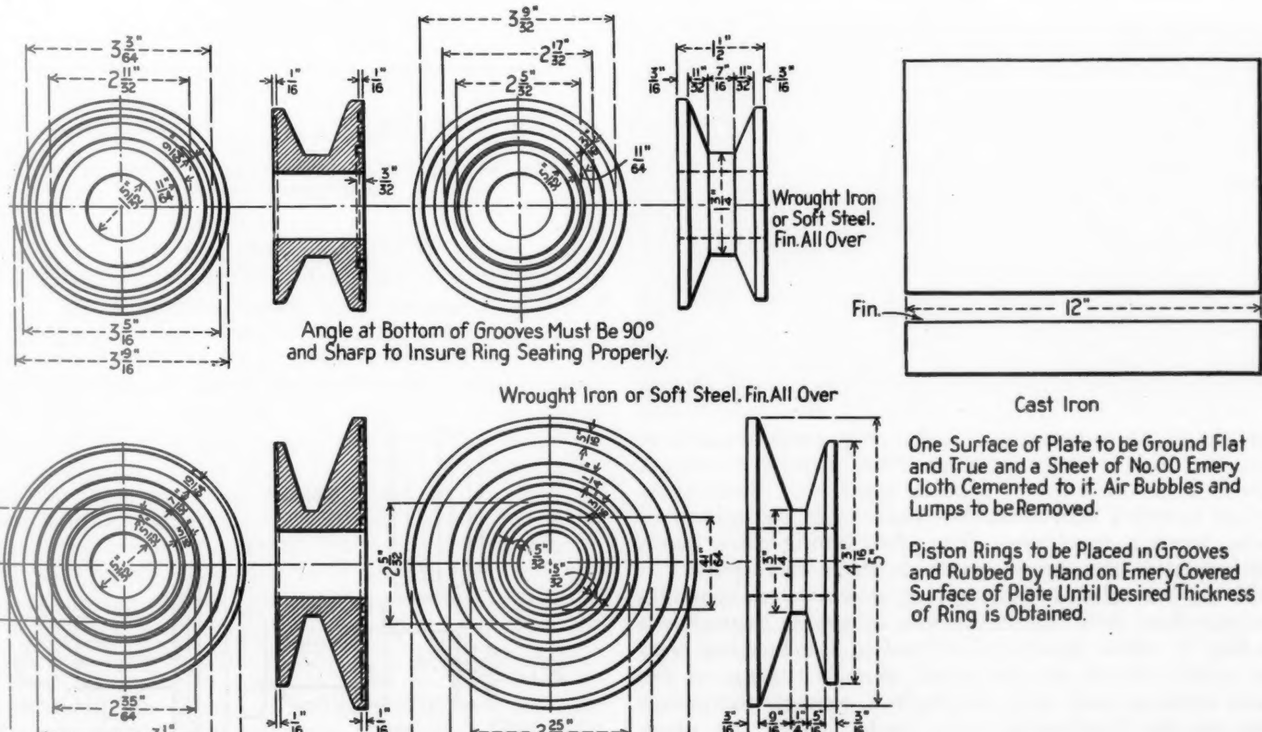


Fig. 5—Ring lapping holder and plate

Fig. 6—Gage for checking distributing valve upper cylinder cap

If the valve meets the requirements as called for in the test code, the test-rack operator places his mark on the marker plate and passes the valve on to a helper stationed nearby who plugs the openings and places the valves in a container to be delivered to the stores department.

Repairs to Distributing Valves

If repairs are necessary, the test rack operator lists on a special form inserted in the exhaust opening any defects found in the valve and it is then delivered to

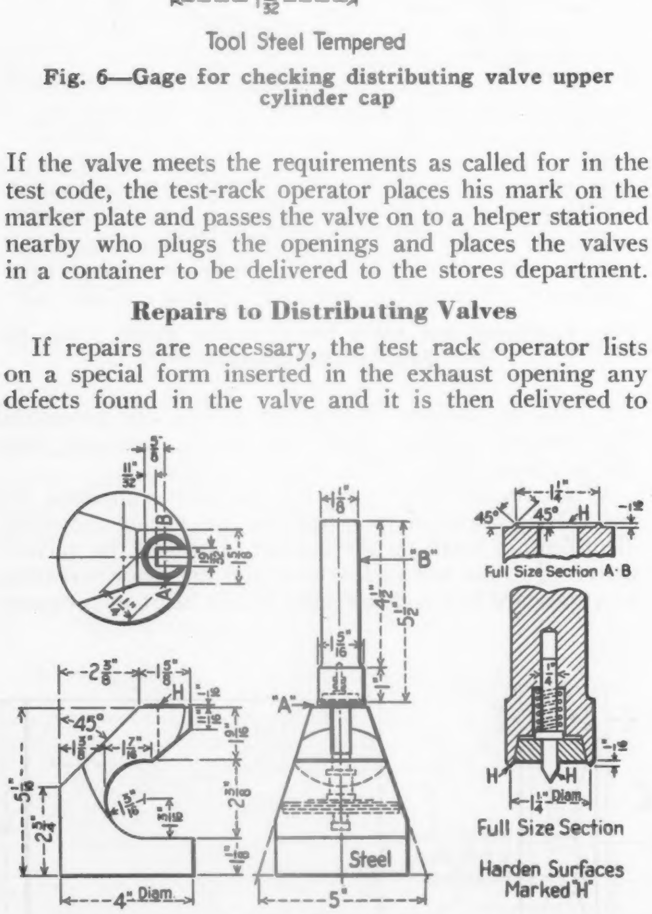


Fig. 7—Jig for straightening wing on end of equalizing piston of distributing valve

the repair station in the shop. In the event that repairs to slide valves and seats are necessary, the valve bodies are placed on a reciprocating lapping machine, and in case the slide and graduating valves require reseating, this is done on a rotary lapping machine. Illustrations in last month's article on the triple valve show both of these lapping machines. The distributing-valve parts are lapped in the same manner as triple-valve parts.

If the test shows packing-ring defects, the cylinders are gaged for wear with a cylinder calipering gage shown in Fig. 2. This device is inserted in the bushing with the points *A—A* and the pivot point B resting on the lower cylinder wall until the angle *C* contacts the gasket face on the distributing valve body. With the pivot point *B* resting on the lower wall and the indicator point *D* in contact with the opposite wall of the cylinder the crosshead *E*, which is fastened to the indicator gage, is moved back and forth in the guide *F*. With the crosshead moving the indicator pin actuates the gage which indicates in thousandths of an inch the variations in the cylinder wall. This variation must be less than .002 in. The test is made on at least three points around the circumference of the cylinder and if it shows too much wear the valve body is sent to an internal grinder to be reground for an over-size packing ring. The position of the angle *C* on the guide bottom can be adjusted to conform to cylinders of various depths. The additional varying lengths of the indicator pin *D* are used for different size cylinders. The details of this cylinder calipering gage were shown in Fig. 8 on page 202 of the May *Railway Mechanical Engineer*.

Piston packing rings are selected with the aid of a set of gages shown in Fig. 3. The various sizes of piston packing rings are shown in the table referring to the sketch in Fig. 4. If gage No. 1, for example, does not enter the cylinder, a No. 1 ring is used. If gage No. 1 does enter the cylinder, a No. 2 ring is used, and so on, until, as may be the case, a No. 4, gage enters. When this happens the bushing is considered too large and the valve body is returned to the manufacturer for rebushing. Lapped joint rings are used exclusively.

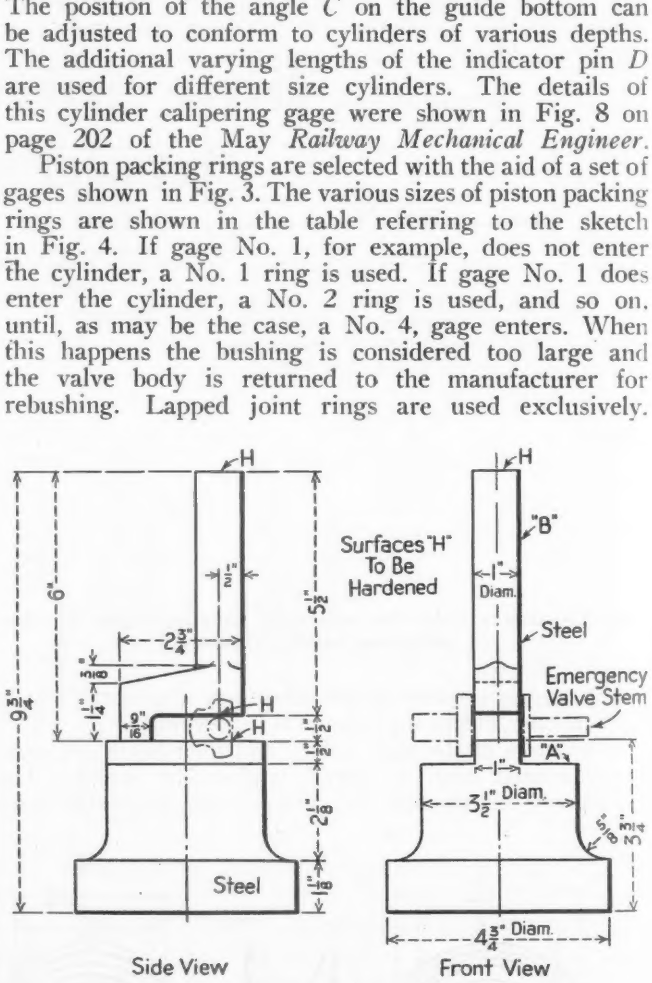


Fig. 8—Jig for straightening distributing valve emergency valves

When piston packing rings are too wide for the ring groove they are reduced in thickness by the use of a ring holder and lapping plate shown in Fig. 5.

Pistons having worn or defective packing ring grooves are returned to the manufacturer for repairs and application pistons, with worn baffle plates and spiders, are

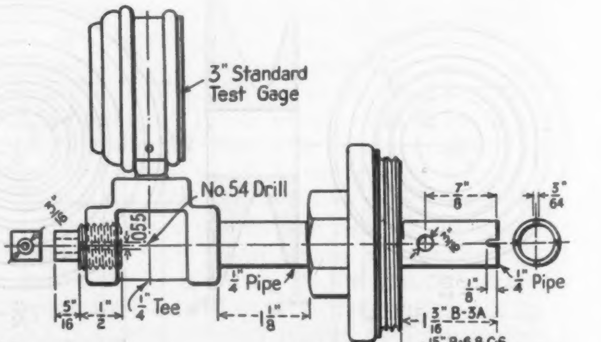


Fig. 9—Device for testing leakage in feed valve pistons

handled in the same manner. The various springs used in the valves are carefully checked for length, number of coils and general condition. Distributing valves with broken or cracked bodies are returned to the manufacturer for welding if their condition warrants it. Worn threads in the safety-valve openings are repaired by tapping out to a larger size and applying a threaded bronze bushing to bring back the opening to standard. Difficulty is sometimes experienced in preventing the application valve from traveling to the right beyond the lap position which permits air from the main reservoir to escape into the brake cylinder when it is not desired. This is caused by wear on the inner face of the upper cap nut, a condition brought about by the constant striking of the application piston graduating stem when the piston moves to the extreme right. This condition is remedied by building-up the cap nut by welding and machining it to the original dimensions. The gage used for checking the upper cylinder cap is shown in Fig. 6. Worn or distorted equalizing piston

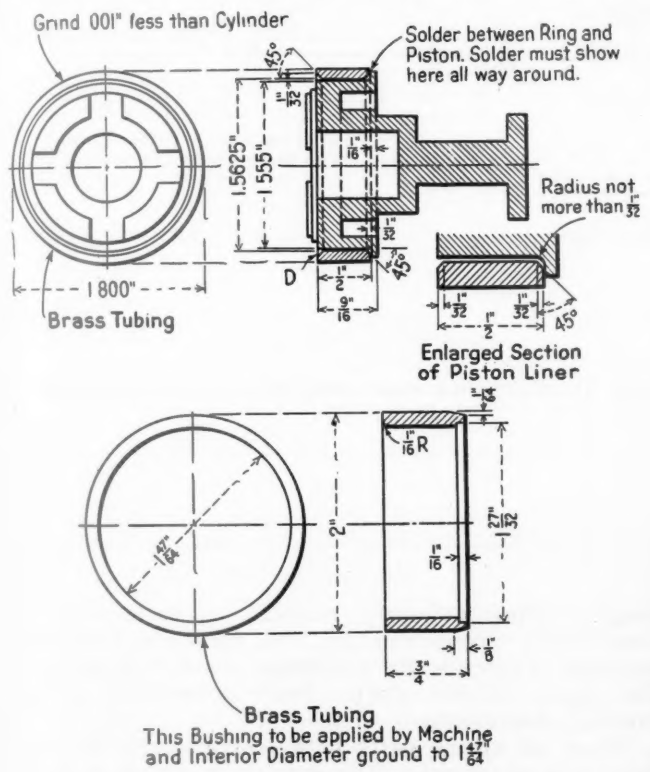


Fig. 10—Methods of repairing feed valve piston and bushing

wings are restored to normal by means of a device shown in Fig. 7. The piston is placed with the wing resting on the anvil base *A* and the flanger *B* is placed on the top face of the wing with the movable center in the flanger inserted in the piston center. A light tap with a hammer is usually sufficient to remedy the worn or distorted condition. Difficulty is sometimes experienced in keeping the emergency slide valve and the quick-action cap seated. This is caused by a distortion in the emergency valve stem and, in order to correct the trouble, the device shown in Fig. 8 is used to good advantage. The stem is placed sidewise over the anvil at *A* and an ell-shaped tool *B* is placed on the upper face of the stem. While it is in this position a light blow with a hammer on the upper end of the tool corrects the difficulty.

After all of the parts of the distributing valves have been returned to the repair station, a workman laps the slide valves to the seats with oil and laps the piston-packing ring to a bearing on the cylinder wall, using oil during the operation. Usually a few strokes are all that is necessary for either of the above operations. The valve is then lubricated and assembled in the same manner described for the cleaning operation, the workman's identifying stamp being placed on the marker plate before the valve is delivered to the test rack. When the test has been completed and the valve found ready for service the test-rack operator adds his mark and turns the valve over to a nearby helper who plugs all openings and places the valve in a container for delivery to the stores department.

The E-7 safety valve used in connection with the distributing valve is dismantled and the parts cleaned in a turpentine substitute, after which the necessary repairs or renewal of parts is made. The valve is finally assembled and tested on a standard test rack. Valves on which the threaded portion of the body has become damaged are repaired by means of a brass adapter.

Approximately 225 distributing valves are cleaned or repaired at the Pitcairn air-brake shop each month.

Feed Valves

Most of the 4,800 steam locomotives on the Pennsylvania System are equipped with one or both of the two following feed valves. The newer type, known as the M-3-a feed valve, is used to regulate and maintain a pressure in the brake pipe and is of a capacity sufficient to meet the demand of long freight trains. The older type, the C-6 feed valve, is used principally as a reducing valve for maintaining pressure in the reducing valve pipe on the independent brake and on the signal line on passenger trains.

Feed valves are tested with the device shown in Fig. 1. By placing the engineer's brake valve in the running position and opening the cock leading to the choke fitting

Feed valve dismantling and cleaning bench showing trays of parts on the shelves

containing the 1/16-in. orifice brake-pipe pressure is released to the atmosphere.

The feed valve must maintain brake-pipe pressure with a fluctuation of not more than 2½ lb. from the pressure to which the valve is set. When the C-6 feed valve is used as a reducing valve for the signal line the following test is made: After all leakage is eliminated from the signal line the test device is attached to the signal hose at the rear end of the tender and the cock leading to the choke fitting containing the 1/16-in. orifice is opened to the atmosphere. The reducing valve must maintain signal-line pressure constant or with a fluctuation of not more than 2½ lb. of the pressure at which it is set. Feed

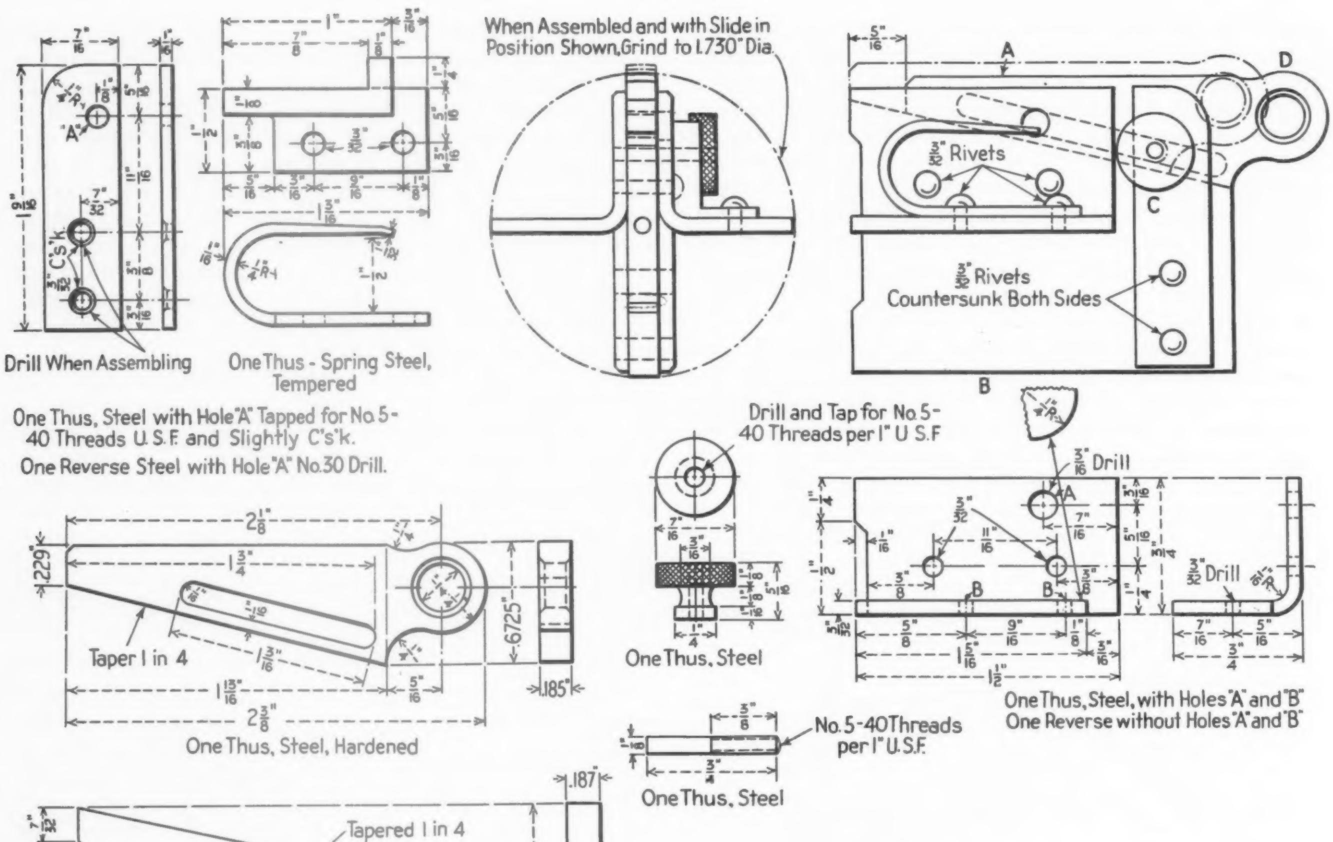


Fig. 11—Calipering gage used on feed-valve cylinders

valves are removed at least every six months for cleaning, oiling or necessary repairs.

When feed valves are received at Pitcairn they are loaded into containers and taken into the shop to the section set aside for the feed-valve repairs. The arrangement of the facilities in this section consists of two benches, back to back. Several rows of open shelves project above the bench tops and are located between them. Valves are taken from the container and dismantled, the parts for each individual valve being kept together by the use of a small metal tray of sufficient size to hold the parts of one valve after being dismantled.

Inasmuch as there is some difference in the construction of the M-3-a and the C-6 feed valves the methods used in repairing the C-6 type will be described first.

The tray containing the dismantled parts is placed on one of the open shelves within reach of the workman whose duty it is to clean the parts. Here all internal parts which require cleaning are gone over with a turpentine substitute, care being taken to remove all foreign deposits from the ports in the valves and their seats. The length of the regulating valve stem is kept within proper limits by the use of a gage shown in Fig. 13, which is placed on the annular projection or shoulder in the diaphragm chamber. The stem end should just clear the gage. If it does not, necessary adjustments are made either by shortening the stem by means of filing or squeezing the stem to increase its length. When necessary renewals of such parts as diaphragms, springs, cap nuts, etc., are made. Particular attention is given to the diaphragm shoulder to see that the edges are not sharp. Such a condition causes cracked diaphragms.

When all of the parts have been cleaned they are lubricated as follows: The slide valve and its seat are lubricated by a sparing application of high-grade cylinder oil. No lubricant whatever is applied to the piston or the cylinder. Cap nuts are coated lightly with oil and graphite.

When the cleaning operation is completed the workman assembles the valve, but for reasons which will be explained later in the article the spring box assembly and the piston cap nut are not tightened up but are merely screwed in lightly by hand. The workman places his identifying mark on the top face of the bolting flange and the valve is placed in a bin within easy reach of the test rack operator. The first tests made after the valve is placed on the test rack are those to determine the condition of the supply valve piston, the slide supply valve and the regulating valve. Next, the spring box assembly and the piston cap nut are removed and a device shown in Fig. 9 is screwed into the piston cap-nut opening. Leakage in the regulating valve may then be noted, as one end of the valve is exposed. If the slide valve is leaking it will be indicated by a blow from the port at the side of the regulating valve in the recess

under the diaphragm. Leakage past the piston can be noticed on the gage attached to the test device. The pressures shown on the gage should not be less than 20 lb. nor more than 60 lb. to the sq. in. If it should be below this minimum it is an indication that the piston is too tight and, if above the maximum, that the piston is too loose. In the event that a leaking regulating valve is the only defect, repairs are made by the test-rack operator. This is accomplished by inserting a screwdriver in the small slot in the cap-nut end of the valve and turning the valve with a reciprocating motion using powdered pumice as an abrasive. Should the piston be too tight an adjustment is made by removing a small amount from the piston with a piece of fine emery cloth. If the piston is too loose, further tests are discontinued and the valve is passed to the repair bench. Should the valve pass the required test the operator places his identifying mark on the bolting flange adjacent to the mark placed by the cleaner, in addition to the stamp designating the shop at which repairs were made. A metal protector is clamped through the bolt holes in the bolting flange and the valve is placed in a container to be taken to the stores department.

The valves which fail to pass the test after being cleaned and lubricated are placed in a double bin within reach of the repair bench, one side of the bin being for valves with loose pistons and the other for valves having defective slide and regulating valves. The repair man takes the valves apart for repairs and distributes them according to the nature of the repairs required. Should slide valves or seats in the body require reseating, this is taken care of on the rotary and reciprocating lapping machines which are located directly across the 6-ft. aisle from the feed-valve repair section. In order to avoid misplacing a piston which is not defective, it is returned to the bushing after the slide valve has been removed. During the lapping operation the piston is placed on the table near the valve being lapped and when the lapping is completed it is replaced in the bushing. On feed valves having defective pistons the pistons and the slide valve are removed and the regulating and spring-box portions are loosened but not removed from the valve body. Valves requiring repairs are then placed in the bin within reaching distance of a lathe-hand.

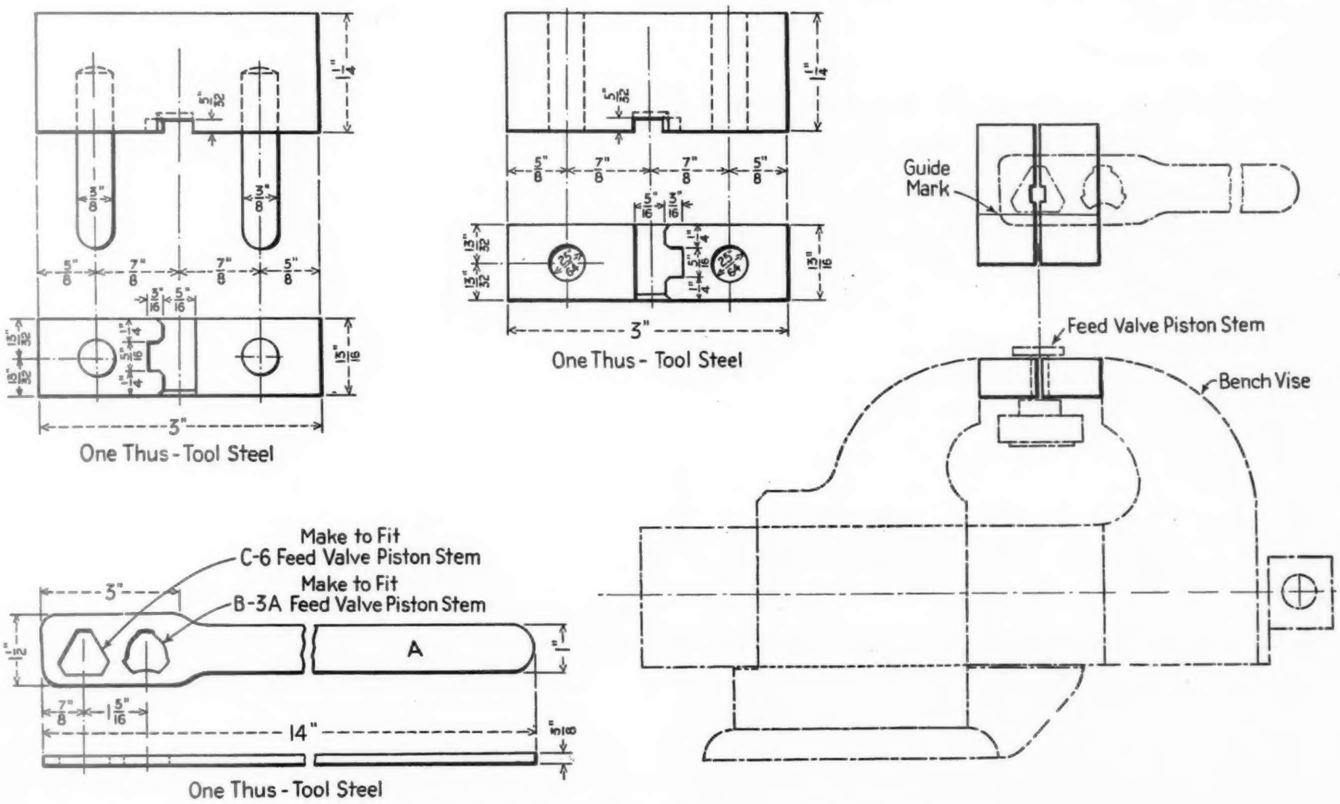


Fig. 12—Device for straightening feed valve piston stems

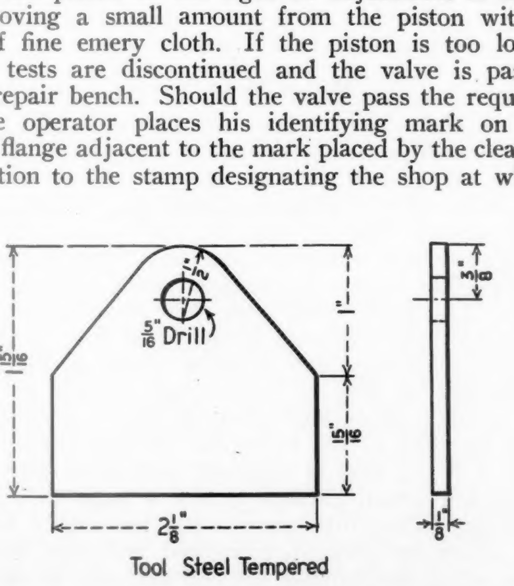


Fig. 13—Gage for checking feed valve regulating valve stem length

Worn or cut bushings are trued up and another piston fitted having a tolerance of .001 in. When the bushing becomes too large for the maximum size piston a new bushing is applied.

Worn pistons are trued up until they eventually become too small, when a ring or liner is applied to the piston head as shown in the upper part of Fig. 10. Piston liners are finished to 1.800 in., being made from brass tubing and soldered in place. The standard piston size is 1.750 in. and the over-size pistons are 1.775 and 1.800 in. The bore of a new piston bushing is finished to

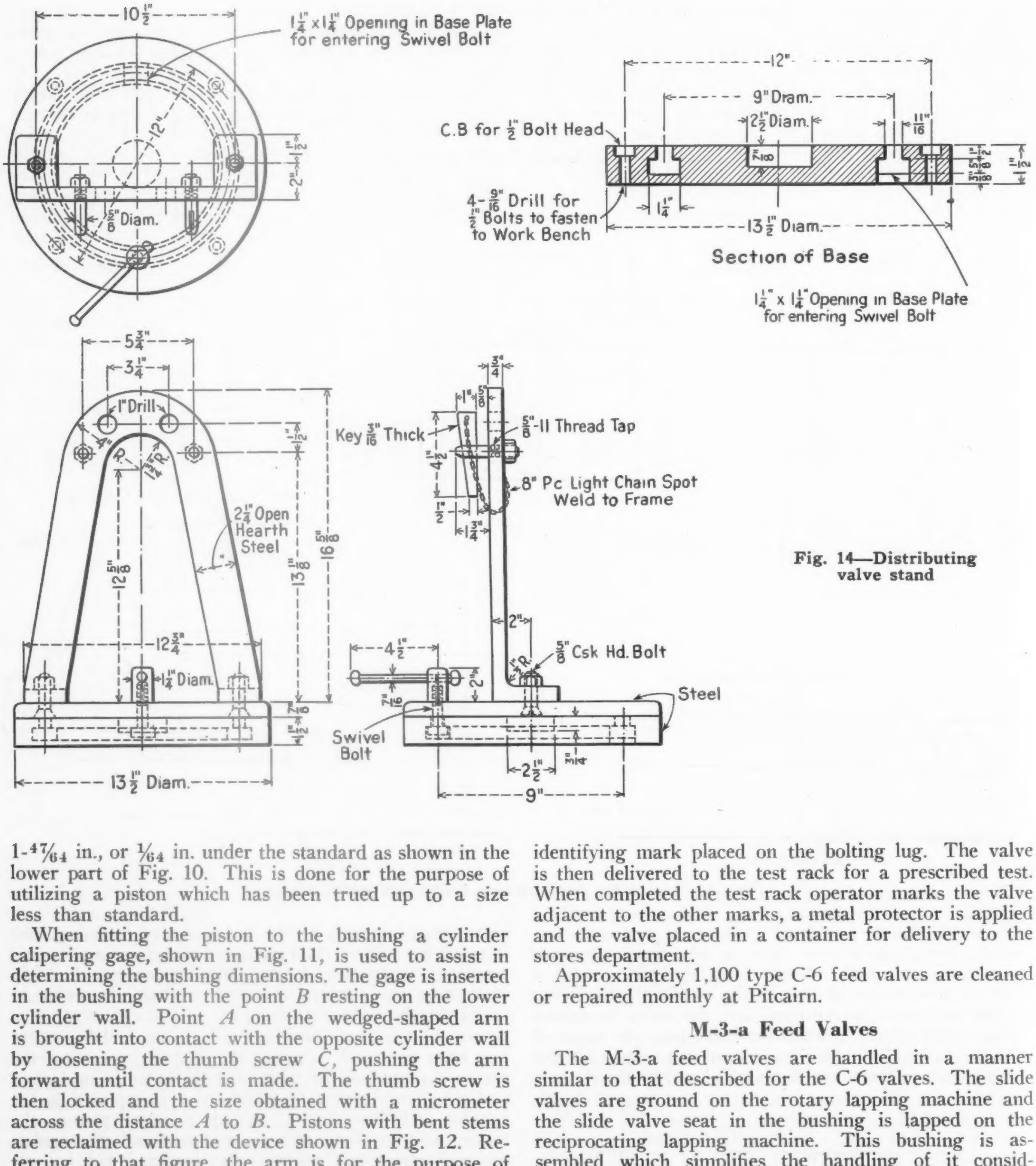


Fig. 14—Distributing valve stand

1-47/64 in., or 1/64 in. under the standard as shown in the lower part of Fig. 10. This is done for the purpose of utilizing a piston which has been trued up to a size less than standard.

When fitting the piston to the bushing a cylinder calipering gage, shown in Fig. 11, is used to assist in determining the bushing dimensions. The gage is inserted in the bushing with the point *B* resting on the lower cylinder wall. Point *A* on the wedged-shaped arm is brought into contact with the opposite cylinder wall by loosening the thumb screw *C*, pushing the arm forward until contact is made. The thumb screw is then locked and the size obtained with a micrometer across the distance *A* to *B*. Pistons with bent stems are reclaimed with the device shown in Fig. 12. Referring to that figure, the arm is for the purpose of taking the twist out of a piston wing, which is accomplished by placing the opening in the arm over the wing and turning it until the wing is lined up with the piston stem. When the necessary machine work has been completed on the piston and the bushing the feed valve is taken to the rotary or reciprocating lapping machine to have the slide valve and seat lapped in.

A grinding compound mixed with signal oil is used for the purpose. Valves are then returned to the repair bench to be given the necessary attention which consists of rubbing the slide valve over the seat for a few strokes, using oil during the operation. Parts are lubricated and the valve assembled in the manner described for cleaning and oiling and the repair man's identifying mark placed on the bolting lug. The valve is then delivered to the test rack for a prescribed test. When completed the test rack operator marks the valve adjacent to the other marks, a metal protector is applied and the valve placed in a container for delivery to the stores department.

Approximately 1,100 type C-6 feed valves are cleaned or repaired monthly at Pitcairn.

M-3-a Feed Valves

The M-3-a feed valves are handled in a manner similar to that described for the C-6 valves. The slide valves are ground on the rotary lapping machine and the slide valve seat in the bushing is lapped on the reciprocating lapping machine. This bushing is assembled which simplifies the handling of it considerably. The piston is equipped with a packing ring having a step cut or lap joint. The manner of determining the proper size ring is shown in Fig. 3, the *rings* being furnished in four sizes as shown in the table of dimensions in Fig. 4. The gages shown in Fig. 3 consist of a set of four sizes. If No. 1 gage does not enter bushing, a No. 1 ring is required, but if it does enter a No. 2 ring is required, and so on until a size is reached which permits a No. 4 gage to enter the bushing. When this happens the bushing is scrapped. The valves are cleaned, lubricated and then tested and those which fail to pass the test are sent to the repair bench to be dismantled and necessary repairs made. In lubricating the M-3-a valves the slide valve and seat

are coated with a special triple valve grease and the packing ring and the cylinder are lubricated sparingly with an anti-friction oil. After being cleaned or repaired the valves are tested on a standard Westinghouse test rack according to a code of tests adopted by the railroad company. A sheet-iron marker plate is fastened across the cover plate for the purpose of indicating where the valve was repaired and the identifying marks of the repairman and inspectors. A metal pro-

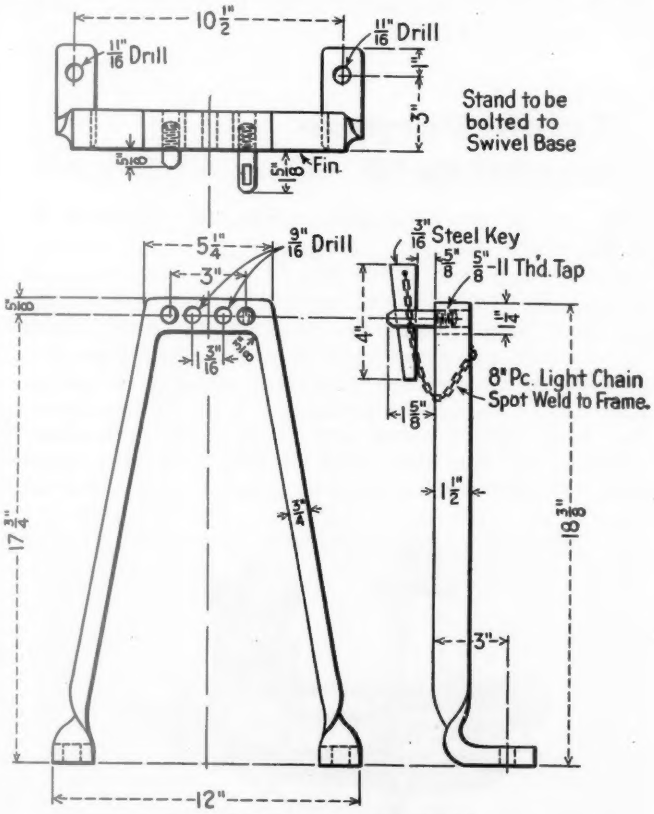


Fig. 15—Feed valve stand

tector of a design similar to that used with the C-6 valves is then placed on the valve and it is ready for placing in containers for delivery to the stores department.

Approximately 130 type M-3-a feed valves are cleaned or repaired each month at Pitcairn.

Two of the stands developed for holding distributing and feed valves during the various dismantling, cleaning and repair operations are shown in Figs. 14 and 15.

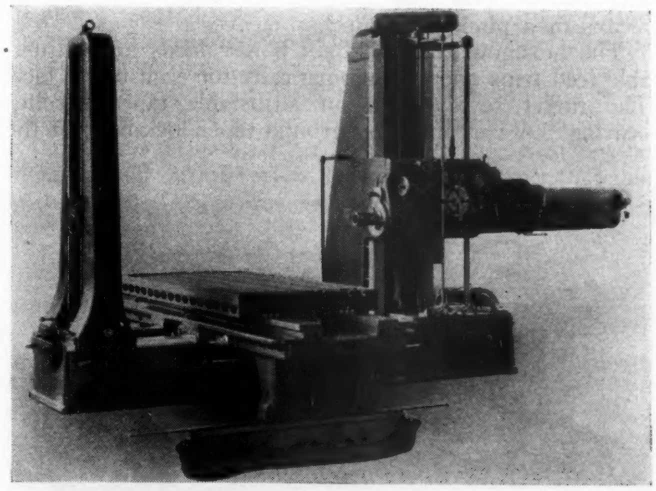
Bench and Pedestal Grinders

Among the shop tools recently placed on the market by the Stanley Electric Tool Division, The Stanley Works, New Britain, Conn., are a 7-in. and 10-in. grinder with long spindle construction which provides more space between the wheels and the motor, simplifying the grinding of large, odd-shaped pieces. These grinders have fully enclosed wheel guards with end covers which fit over the rims of the guards. These guards are easily adjusted for grinding at any point on the wheel circumference. The tool rests are mounted on the wheel guards and are adjustable to follow wheel wear. The spindles are mounted in ball bearings fully enclosed. Tapped holes are provided in the wheel guards for attaching Stanley safety eye shields if desired.

The 7-in. grinder known as No. 557 is equipped with two 7-in. by 1-in. wheels (one coarse and one fine). It is driven by a 1/3-hp. motor, has an overall length of 19¾ in. and weighs 75 lb. The 10-in. grinder, known as No. 610, has two 10-in. by 1-in. wheels, is driven by a 1/3-hp. motor, and has an overall length of 24 in. The shipping weight is 160 lb. Either of these machines may be used as bench or floor machines, suitable pedestals for floor mounting being available.

Horizontal Boring, Drilling And Milling Machine

The illustration shows one of a series of improved horizontal boring, drilling and milling machines marketed by the Giddings & Lewis Machine Tool Company, Fond du Lac, Wis. This group of machines, known as the Series 30, are particularly adapted to the use of the new cutting tools, such as tungsten carbide, which require a powerful, accurate spindle drive. In order to assure precision performance these machines are built with two spindles, a large main spindle running at 500 r.p.m. for boring and heavy milling and a small, light high-speed spindle which operates at 1,500 r.p.m. Both spindles are driven by herring-bone gears and run in anti-friction bearings. A clutch arrangement permits cutting out the main spindle when the high-speed spindle is in use thereby eliminating any flywheel effect. An-


Giddings & Lewis horizontal boring, drilling and milling machine

other feature of these machines is the directional control by means of which such parts as table, saddle and headstock always move in the direction that the control levers are moved regardless of the direction of rotation of the spindle.

The machine illustrated is a standard No. 350-T having a 5-in. main spindle and a 2-in. high-speed spindle. Each spindle has a selection of 36 speeds ranging on the main spindle, from 6.25 to 375 r.p.m. and, on the high-speed spindle, from 25 to 1,500 r.p.m. The main spindle has 18 feeds, from .010 in. to .500 in. and the high-speed spindle has the same number of feeds ranging from .002 in. to .125 in. The main spindle has a

longitudinal travel of 36 in. and the high-speed spindle a 9-in. travel.

The center distance between the spindles is 8.75 in. and the maximum distance from the table top to the center of the main spindle is 48 in. The working surface of the table is 36 in. by 72 in. and the cross travel of the table is 60 in. The machine is driven by a 1,200-r.p.m. 15-hp. constant-speed motor. The net weight is 30,000 lb.

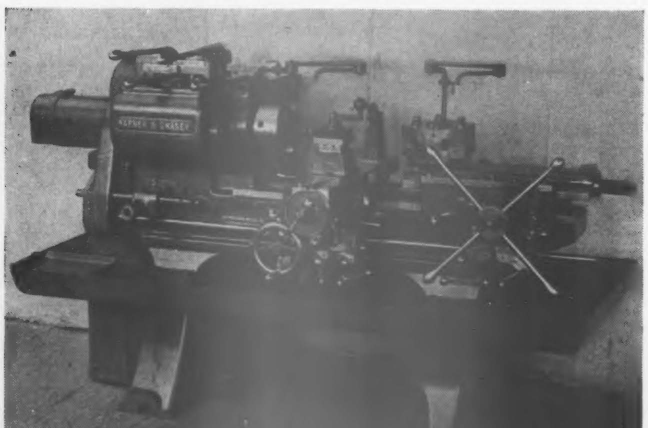
Universal Turret Lathe

AMONG the new turret lathes recently developed by the Warner & Swasey Company, Cleveland, Ohio, is a No. 4 universal machine having a bar capacity of 1¾ in. diameter and chuck capacity of 18 in. This machine is designed for fast operation with a minimum of effort on the part of the operator and the controls have been so arranged as to be of easy access to the operator from his normal working position.

The universal cross-slide carriage and hexagon turret operate entirely independent of each other and all feeds have uniform increments. The cross-slide carriage has six reversible power feed changes, both cross and longitudinal. Six adjustable stops trip the longitudinal feed at any desired point. The square turret has automatic indexing and a large micrometer dial on the cross slide allows widely spaced graduations for measuring accurately the depth of the cut.

Pressure lubrication in both aprons keeps the bearings clean and free from grit and prevents washing the lubricant away. The slide and bed ways are lubricated by means of a plunger pump.

The hexagon turret has six power feeds and adjustable feed trips operate automatically for each turret face. The turret revolves on an adjustable tapered roller bearing. A hardened and ground taper lock-bolt for the turret works into a hardened and ground taper bushing located at the front of the slide directly under the cutting tool.



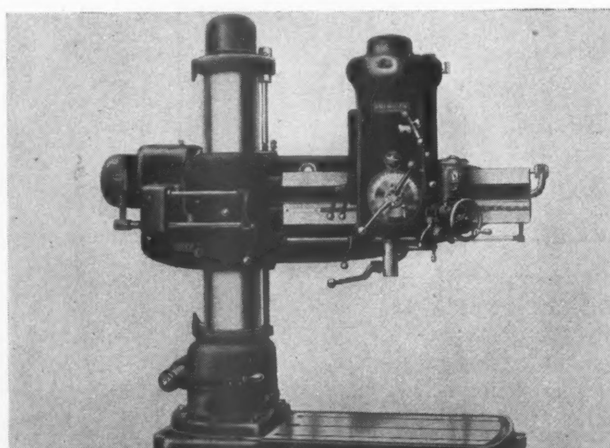
Warner & Swasey No. 4 universal turret lathe

The all-geared head has 12 speeds and is designed for high-speed operation with modern tungsten-carbide cutting tools. The entire gear assembly is mounted in a one-piece head and bed casting. The spindle and all gear shafts run in roller bearings. Multiple disc clutches control the speed changes. The head is lubricated by a splash system. All speed lever positions are direct reading and in the direct line of vision. No chart is necessary in order to determine lever positions. The motor drive is by means of silent chain or multiple vee belts and the motor, mounted directly under the head, is completely enclosed.

The floor space required by the machine is 3 ft. 2 in. by 7 ft. 10 in., exclusive of the bar feed rod, and its net weight is 3,700 lb.

Triple Purpose Radial Drill

AMONG recent developments of the American Tool Works Company, Cincinnati, Ohio, of interest to railroad shop men is the line of American Triple-Purpose radial drills ranging in arm lengths from 3 ft. to 12 ft. These radials are designed to handle a wide variety of operations varying from large boring and tapping to the average high-speed drilling in cast iron and steel. The quadruple geared head of this machine has four speeds which are divided into two distinct ranges; one for high-speed drilling and light tapping and the other for heavy tapping and boring. The head mechanism is fully enclosed, there being no running parts exposed. In the design of these American radials specific attention has been given to the centralizing of controls so that it is possible to operate the machine from the normal working position. The gear box speed control levers have been extended to the arm girdle, where on all smaller size machines they can be reached without moving from the operating position, while on the larger sizes rarely more than one step is ever required to reach them. Through these two levers the six gear box speeds can be controlled. From the head, with a movement of the lever, the operator may clamp or unclamp and raise or lower the arm through a safety elevating mechanism. To make the swinging of the arm easy a special ball bearing is interposed between the column and sleeve at the bottom while at the top a ball bearing is interposed to take the radial thrust of the sleeve. The column binding lever extends well to the front, where it can be conveniently reached by the operator.


American Triple-Purpose radial drill

Typical of this line of American radials is the 5-ft. radial with a column 15 in. in diameter. This machine will drill to the center of a 120-in. circle and has a maximum distance from spindle to base of 66 in. The spindle traverse is 18 in. and the hole in the spindle will take a No. 5 Morse taper. The traverse of the drill head on the arm is 49¼ in. and of the arm on the column 33½ in. This machine has 15 feeds having a range of .004 in. to .125 in. The spindle speeds range from 23 to 1,200 revolutions per minute. The net weight of the 5-ft. machine is 13,000 lb.

Oxy-Acetylene Welding and Cutting in the Shop*

By D. C. Reid†

WHILE the oxy-acetylene process as applied to the railroad shop is still in its infancy, progress in the education of shop men and shop foremen on the majority of railroads has advanced to the point where the value of the torch as a means of effecting economy in the repair of equipment and in certain fabricating operations is fairly well understood. However, constant development of the art makes it imperative that this campaign of education be continued in order that full advantage may be taken of improvements in equipment, materials and procedures which are constantly being introduced.

In considering the relative merits of various processes available for the completion of repairs, ultimate economy is, of course, the controlling factor. In other words, both the cost and quality of the repair operation must be considered in order that final economy may be rightly determined. A part repaired at relatively low cost which subsequently fails or does not give the expected service does not contribute to economy but on the contrary makes for higher ultimate costs. It is, therefore, necessary in choosing between the various methods affecting detail repairs to determine not only the cheapest method of doing the original work, but also the length of service which may be expected from the repaired article in order that that procedure may be selected which will yield the greatest ultimate economy.

The locomotives which come to the shops for repairs are of numerous types and classes. Further they are used in various classes of service and under widely varying conditions, all of which means that the individual items of equipment when received for repairs are in highly variable condition and it is, therefore, possible only in the most general way to plan repair operations in advance of delivery to the shop. As a general rule the repairs to be made to any item of equipment are determined largely by a detailed inspection made after the locomotive or car has been delivered to the shop and plans for repair can only be made after such inspection is complete.

Stripping Locomotives by Gas Process

The stripping of either locomotives or cars in preparation for repairs presents the first opportunity for the economical application of the oxy-acetylene process. In present practice, the cutting torch is the most important dismantling tool and its use for this purpose insures large economies both in time and cost. In the performance of the one operation of removing fireboxes or firebox sheets which are in need of renewal the cutting torch has speeded up and helped to balance shop operations. Before the advent of the cutting torch the stock alibi for all departments when work was delayed was "waiting on the boilermakers."

At the present time, thanks to the superior speed of the cutting torch the boilermakers are able to get the jump on the machinists and to complete their work in such time that total days in shop for engines requiring new fireboxes or heavy boiler work have been greatly reduced.

The same thing applies in greater or less degree to all of the stripping operations. It is no longer necessary for the strippers to spend hours in drilling or shooting refractory bolts or in removing frozen nuts and the whole dismantling operation has been speeded up to the point where many hours of time are saved in getting the equipment to the point where actual repair operations can be started.

In the use of the cutting torch for dismantling operations it is necessary, however, to avoid the destruction of usable material the cost of which would outweigh the economy between cutting and removing by other methods. In order to avoid the destruction of usable parts it is necessary that the inspector or foreman determine in advance where the cutting torch should be used and where other methods of removal should be employed. As a general proposition it may be said that parts which are not to be replaced can be more economically cut with the torch than removed by other methods.

While the economies resulting from the use of the cutting torch in stripping locomotives and cars preparatory to the completion of general repairs is a spectacular operation from which large savings per unit of equipment are secured, the use of the same torch in speeding up and reducing the cost of running repair operations is a no less important application.

The removal of staybolts or flues in small lots or in scattered positions is not only economical from a cost standpoint but materially reduces the time each engine must be held out of service for repairs. Equally valuable is this method of cutting bolts, nuts and other fastenings when the removal of machinery parts is required.

The modern enginehouse which is not equipped with facilities for flame cutting is badly handicapped in the requirement of keeping power moving at the least possible cost and with the greatest feasible dispatch.

Another very important field in which the cutting torch is predominant is in the dismantling of obsolete equipment which has been written off the books and is to be sold as scrap, and in the reduction of all metal scrap to charging-box or furnace size, in which condition it commands the highest market price.

A differential always exists between the market price of cut and sorted scrap and uncut miscellaneous scrap which more than covers the cost of handling and cutting and provides a margin of profit. The railroads which cut their own scrap to proper sizes for use by the steel mills and sort it into the required grades realize a substantial profit by so doing.

The introduction of the oxy-acetylene welding process has made it possible to repair by welding cracks or fractures or by building up worn surfaces and to continue in service large quantities of material which it was previously necessary to scrap and replace with new parts.

Heavy Repairs Involve Many Welding Operations

Locomotives undergoing repairs are in the shop for periods of from a few days to several weeks and the

* Excerpts from a paper presented before the thirty-fifth Annual Convention of the International Acetylene Association.

† General superintendent of motive power, Boston & Maine.

welding and machining of parts for replacement can be accomplished in such time as not to delay the procedure. Parts such as pistons, crossheads, guides, motion work, rods and other running-gear parts and boiler and machinery appliances are delivered after stripping to the department where detailed inspection and repairs are to be made. In the larger shops it has been found advisable to set aside a bay or section where all movable parts requiring welding or building up are sent and where a crew of welders equipped with the necessary tools and facilities are provided to perform the welding operations. Such an arrangement insures maximum economy by the elimination of any lost time by the operators in moving from point to point about the shop and also makes supervision of welding operations more effective as the foreman in charge has the work under his immediate observation at all times. There are, of course, numerous welding operations which must be done on the erecting-shop pits. Such work as the welding of frames, cylinders, guide yokes or driving-wheel spokes must obviously be done on the floor as the movement of such parts to a central location would entail large expense. For work of this nature it is advisable to have a special crew of men thoroughly familiar with the procedures required.

The welding of locomotive cylinders or frames by the oxy-acetylene process yields large economy provided that the work is done in such a way that subsequent failure does not result. We know from experience that welds in the largest frame sections and in cylinder and other large castings can be made in such a way that the repaired part is the full equivalent of new material, but in order that the desired result shall be secured it is necessary that the proper procedure in preparation, welding and subsequent heat treatment be carried out. These ends are insured by the employment of competent welders and the provision of adequate supervision.

Another important application of the oxy-acetylene process is in the heating of parts to be bent, straightened or laid up. By the use of the ordinary welding torch it is frequently economical to make bends in pipes at the time of their application and to take heats on running-board or other brackets to secure proper alinement, thereby eliminating the time otherwise required for mechanics to travel back and forth from the blacksmith or pipe shop to the erecting shop. Either the ordinary welding torch or a special heating torch is also a time and money saver in the laying up of firebox sheets or patches and in straightening parts on locomotives and cars which would otherwise require removal and handling through the blacksmith shop.

The Shape-Cutting Machine

Up to the present the oxy-acetylene processes have been used almost entirely in connection with repair operations and relatively little has been done in the way of developing their possibilities in fabrication and construction. One exception to this general statement is found in the use of the automatic shape-cutting machine in the manufacture of certain locomotive parts.

The cutting machine, together with its appurtenant preheating and normalizing furnace, effects economies in the manufacture of a large number of equipment parts ranging from piston nuts and rod collars to heavy locomotive frame sections and guide yokes. With this machine it is possible to cut from billets or from rough forgings many of the locomotive parts which were previously forged to rough shape at high labor cost in the blacksmith shop or were purchased as castings. In many instances where proper methods of preheating and normalizing are employed these parts may be cut to finished size, eliminating any necessity for subsequent machining. Even on parts where machining is required, in order to secure accurate fits or to eliminate any possibility of surface cracks due to the cutting procedure, the amount of machine work required to finish is reduced to a minimum.

In order to secure the maximum economies which are possible through the employment of the oxy-acetylene welding and cutting processes it is necessary that competent attention be given to the provision of the most efficient facilities and equipment. In shops of such size as require the continuous employment of a number of welders and cutters the distribution of the gases to points of use about the shop is most economically effected through the use of piped distributing systems.

The selection of the proper welding rods for each class of work is a further important factor. In the early days of autogenous welding many failures occurred and much unsatisfactory work was turned out due to the fact that the necessity for providing filling material of proper specifications was not fully understood. During recent years the development of suitable rods for welding any of the common materials of equipment construction has been given competent attention by qualified metallurgists and at the present time it is possible to secure a suitable rod for welding any of the metals in ordinary use. The cost of the filling metal applied in a weld is ordinarily an insignificant part of the total cost of performing the job and too much emphasis cannot be placed upon the statement that the use of suitable rods for each operation should be insisted upon even though the cost of such special rods may be a few cents higher per pound than the price of inferior quality material.

As has been previously pointed out ultimate economy rather than first cost is the important item and the selection of materials for the making of welds should be based upon the service life which the welded or built-up part will give rather than upon the first cost of the filling material.

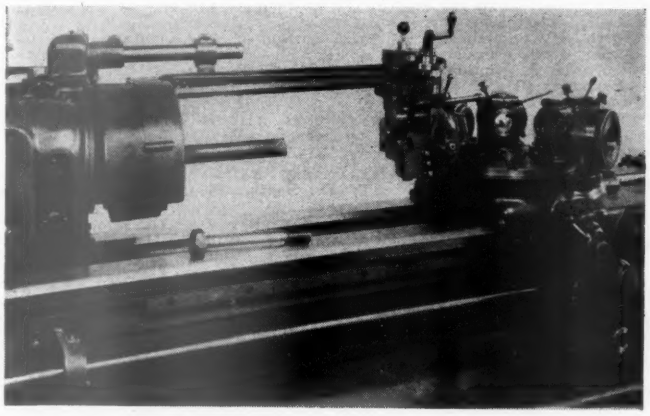
Machining Tapered Bolts On a Turret Lathe

THE Jones & Lamson Machine Company, Springfield, Vt., has recently developed a special attachment for turning locomotive frame bolts on the J. & L. horizontal turret lathe which accommodates bolt lengths up to 24 in. and of various diameters. The attachment requires only one setting of tools which are readily adjustable to different sizes of work.

The taper attachment consists primarily of an overhead former bar which is pivoted from the headstock end of the attachment and a roller back rest turner on the turret. The taper former bar operates between a shoe and a roll on the roller turner. The general arrangement of the attachment is shown in the two illustrations accompanying this article.

In machining tapered bolts the forging is held by a three-jawed air-operated chuck in the hexagon head and the end of the forging is chamfered by a pointing tool on the first position of the turret. The second turret position throws the roller back rest turner into position for turning the taper on the bolt body and the straight thread diameter. In turning the taper of the body of the bolt the shoe and roll on the turner ride on the former bar which has a taper 10 times that required on the work. The adjustment for work diameter is obtained by means of a crank handle carrying a dial graduated in thousandths of an inch. The former bar

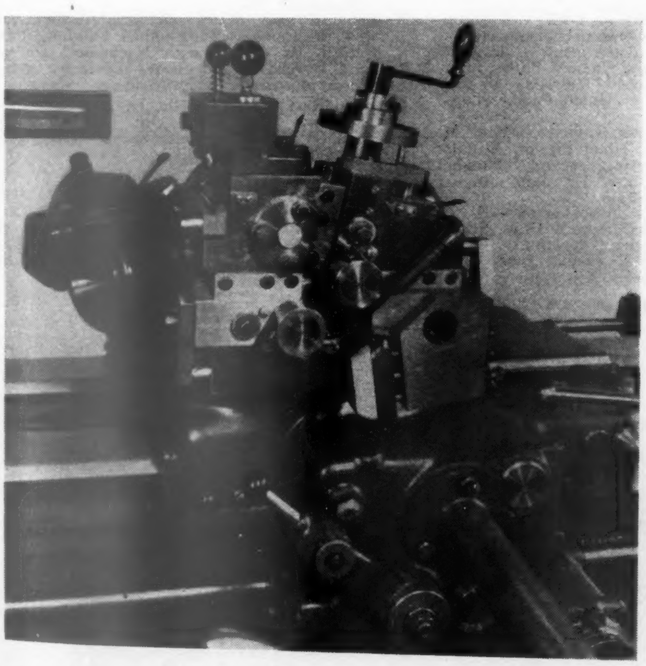
carries a 24-in. scale used for gaging work length. By mounting a pointer on the die head this scale may also be used to gage the length of the thread. After turning the taper and trimming the under side of the bolt head the carriage is run back and the turner is set for the



The J. & L. taper bolt turning attachment

thread diameter. This is done by releasing the taper operating mechanism by means of a binder handle at the back of the turner. A graduated scale on the upper roll carrier aids in setting to the required diameter.

After the thread diameter has been turned and the former bar released and swung out of the way the threading is done by means of a J. & L. automatic die, three



Close-up of the turret, controls, cutters and dies on the J. & L. turret lathe

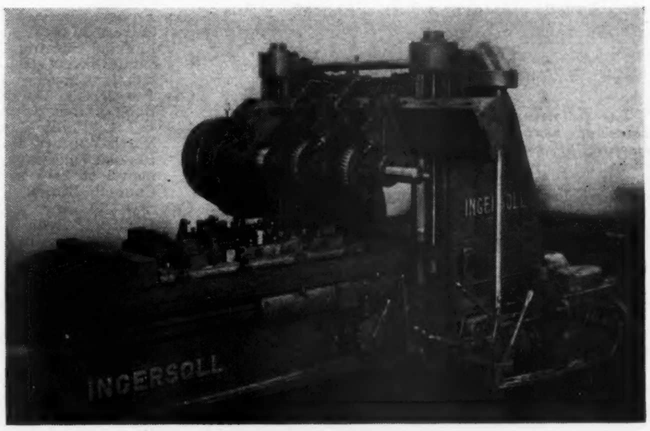
sizes of which are mounted on the turret. The required size is swung into position by indexing the turret. The threading completes the operation and the turner is then moved back into place for turning the next bolt.

The former bar can be released at any position along its length which makes it unnecessary, when turning short bolts, to reverse the carriage the full length of the bar before indexing.

Horizontal Spindle Milling Machine

THE illustration accompanying this article shows a 54-in. by 30-in. by 16-ft. heavy duty horizontal-spindle 75-hp. milling machine built by The Ingersoll-Milling Machine Company, Rockford, Ill., and installed within the past year in a large railroad shop. This machine is used principally for milling locomotive rods and shoes and wedges. Special tooling equipment was designed for use with these machines for milling these locomotive parts in the minimum time. The illustration shows shoe and wedge fixtures on the machine. The machine illustrated is designed primarily for rod and shoe and wedge operations. The 54-in. table is used because it will hold two rods 24 in. across the butt at one time for slabbing or channeling, and still have room in the cutters for an arbor support. The 16-ft. length gives ample room for the longest rods. A pump and large tank assure an ample supply of coolant for any operation. The inclined rail has been in use on Ingersoll machines for many years and is designed to absorb the thrust of heavy cuts. The saddle is integral with the rail so that the spindle is always in alignment with the face of the rail.

The table feed and the vertical feed on the rail are independently controlled so that long radii on the side of rods can be milled by alternately or simultaneously



Ingersoll slab miller set up for milling shoes and wedges

feeding the table forward and the rail down. The table can be locked from the operator's position while feeding the rail down to sink channeling cutters. The levers controlling all of the machine movements are grouped in front of the right hand housing so that the operator has complete control of the machine while watching the cut.

This machine is designed for use with Ingersoll helical inserted tooth milling cutters with which feeds as high as 8½ in. a minute may be used. The average feed used on rod work with these machines is about 5½ in. per minute. The machine shown is driven by a 75-hp. motor.

STREAMLINED TRAINS FOR SOLDIERS—Of interest to railroaders is the fact that streamlined trains will play their part in the present boundary dispute between Italy and Ethiopia. The Italian government, in recent months, shipped several new streamlined trains to its African colony, Somaliland, for use largely in rapid and flexible troop movements.

Among the
Clubs and Associations

The New York Railroad Club's annual outing will be held on Thursday, June 20, at the Westchester Country Club, Rye, N. Y.

Association of American Railroads.—The 1935 meeting of the Mechanical Division will be held at the Congress Hotel, Chicago, Wednesday and Thursday, June 26 and 27. The meeting will be confined to receiving and acting upon committee reports and other business before the division. There will be no exhibits or entertainment features. The meeting of the Purchases and Stores Division will be held a month later—July 23 and 24.

American Society of Mechanical Engineers.—The semi-annual meeting of the A. S. M. E. will be held at the Gibson Hotel, Cincinnati, Ohio, June 18-21. A joint session of the Railroad and Machine Shop Practice Divisions will be held at 2 p.m., Wednesday, June 19, when L. D. Freeman will discuss Railway Equipment Maintenance, and A. Sellers, Jr., Wm. Sellers Company, will present a paper on "How Can Railroad Shops Justify the Use of Modern Machine Tools and Methods."

Directory

The following list gives names of Secretaries, dates of next regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, c/o Westinghouse Air Brake Company, Thirty-fourth floor, Empire State Bldg., New York.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

Association of American Railroads.—J. R. Downes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.
Division I.—Operating.—Safety Section.—J. C. Caviston, 30 Vesey street, New York.

Association of American Railroads (Cont.)
Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
Committee on Research.—H. A. Johnson, chairman (Director of Research, Association of American Railroads), Chicago.
Division VI.—Purchase and Stores.—W. J. Farrell, 30 Vesey street, New York.
Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 W. Thirty-ninth street, New York.
Railroad Division.—Marion B. Richardson, 192 E. Cedar st., Livingston, N. J. Next meeting, Cincinnati, Ohio, June, 1935.
Machine Shop Practice Division.—G. F. Nordenholt, 330 W. Forty-second st., New York.
Materials Handling Division.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.
Oil and Gas Power Division.—M. J. Reed, 2 W. Forty-fifth St., New York.
Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Canadian Railway Club.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

Car Department Officers Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan street, Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month except June, July and August, La Salle Hotel, Chicago, Ill.

Car Foreman's Association of Omaha, Council Bluffs and South Omaha Interchange.—E. R. Phillips, car department, Chicago & North Western Railway, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at 1:15 p. m. at Union Pacific shops, Council Bluffs.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month except June, July and August at Hotel Statler, Buffalo.

Eastern Car Foremen's Association.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

International Railway Fuel Association.—T. D. Smith, 1660 Old Colony building, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha street, Winona, Minn.

Master Boilermakers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

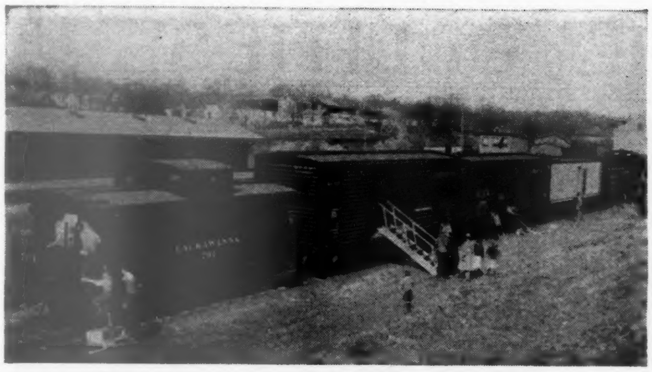
Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, first Friday of each month except June, July, August and September.

Traveling Engineer's Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

Western Railway Club.—C. L. Emerson, 822 Straus building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

* * *

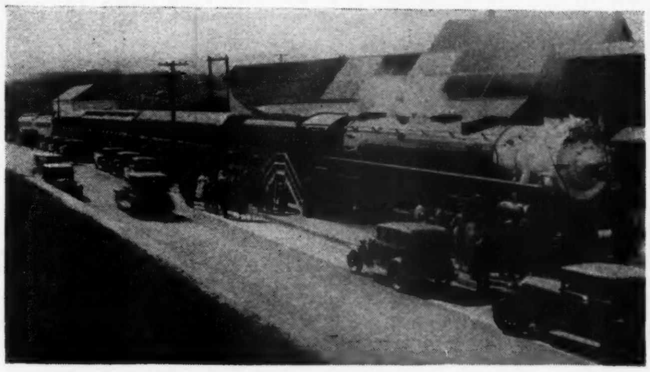
Bulk cement car of covered-wagon type



Photos by T. T. Taber

DELAWARE, LACKAWANNA & WESTERN'S EXHIBITION TRAIN.—The new and modernized passenger and freight power and equipment illustrated was inspected by approximately 170,000 persons during the course of its 24-day tour over the lines of the Lackawanna.

The train consists of a Pocono type (4-8-4) locomotive, a multiple-unit motor car, a multiple-unit trailer car, an air-conditioned coach for through joint New York-Chicago service, a combination chair and seat coach, an air-conditioned steel diner, a Diesel-electric switching locomotive, a steel hopper car, an all-steel box car for carrying flour, a refrigerator car, an automobile car equipped with loader and a caboose.



NEWS

THE ST. LOUIS-SAN FRANCISCO will rebuild 750 wooden box cars at its Springfield, Mo., shops.

THE UNION PACIFIC has named its M-10001 high-speed streamlined, seven-car train, which it will place in service between Chicago and Portland, Oregon, on a 40-hr. schedule, the "City of Portland."

THE CANADIAN PACIFIC has awarded a contract to Th. Borgford & Sons, Ltd., Winnipeg, Man., for the renewal of a portion of the roof of its locomotive shop at the Winnipeg terminals, at a cost of about $40,000.

THE CHICAGO, BURLINGTON & QUINCY has placed an order with the Timken Roller Bearing Company, Canton, Ohio, for roller bearings and boxes for all axles on one 4-8-4 freight locomotive, the engine trucks and tender of which are already equipped with Timken bearings.

Miner Coupler Lock Yoke—A Correction

THE captions under two of the illustrations appearing in the article entitled "The Miner Coupler Lock Yoke" on page 205 of the May issue of the *Railway Mechanical Engineer* are transposed. Fig. 1 should be "Coupler applied ready for application of the lock casting" and Fig. 2, "Miner coupler lock yoke before assembly with the coupler."

Aluminum Colored Bedroom Car on North Western Limited

PULLMAN observation cars with bedrooms, the outside of which are painted with aluminum, have been added to the North Western Limited of the Chicago & North Western operating between Chicago and the Twin Cities. Each of the two cars has six single and two double bedrooms in addition to the observation end and is so constructed that a telescoping partition in the double bedrooms can be adjusted to convert them into compartments with accommodations for four persons.

The addition of the aluminum painted cars to the North Western Limited is coincident with the air-conditioning of the entire train, which is the third train to be air-conditioned by the North Western so far this year, others now in service being the "400" and the "Los Angeles Limited."

Gantt Medal Awarded Arthur H. Young

THE Henry Laurence Gantt Medal for 1935 was awarded to Arthur H. Young, vice-president in charge of industrial relations of the United States Steel Corporation, at a dinner meeting of the Institute of Management, held at the Hotel Pennsylvania, Friday evening, May 24. The medal board is composed of three representatives each from the Institute of Management and the American Society of Mechanical Engineers. The award was made "for outstanding and creative work in the field of industrial relations." Clarence J. Hicks, of Industrial Relations Counsellors, Inc., told of the important part that Mr. Young has played in bringing about better relations between employees and employer. The presentation of the medal was made by Harold V. Coes, of Ford, Bacon & Davis, Inc., and chairman of the award committee.

First P. R. R. Streamlined GG-1 Locomotive Placed in Service

THE first of the Pennsylvania's 57 GG-1 type streamlined electric locomotives was placed in service on the New York-Washington route on May 2. These new locomotives duplicate the original GG-1 in all working parts, but the cab has been redesigned and its plates electrically welded in order to produce a seamless, streamlined unit with a smooth, unbroken surface.

These new locomotives of the GG-1 type are designed to handle passenger trains at speeds of over 100 m.p.h. and as received they will replace in passenger service the non-streamlined electrics hitherto used. The latter, after minor electrical alterations, will be transferred to the freight service.

Complete electrification of passenger service on the New York-Washington was inaugurated on April 7 and on May 20 the first freight train for regular operation by electricity over the same division was placed in service.

Locomotive Tractive Force—A Correction

THE following changes should be made in the article entitled "Locomotive Tractive Force in Relation to Speed and Steam Supply" which appeared in the April issue of the *Railway Mechanical Engineer:*

Page 140, left-hand column, insert the line "and class K4s[5]. The data from these two locomotives over-" between the third and fourth lines of the last paragraph.

Page 140, right-hand column, ten lines from the top, change 206 lb. to 205 lb.

Page 141, equation (5) should read:

$$E_c = 60\,NS \qquad (5)$$

Katy Mechanical Department Performance

THE Missouri-Kansas-Texas mechanical department in 1934 established several records in efficiency. Only one boiler failure was recorded during the entire year, as compared with four the year before and 168 in 1923, the first year in which these records were kept. The average number of miles between boiler failures in freight

(*Continued on next left-hand page*)

and passenger service in 1934 was 10,145,656, a 99 per cent improvement over the performance in 1923, when only 89,863 miles were made between failures.

Locomotives traveled an average of 676,377 miles between failures in 1934, as compared with 526,602 in 1933 and 167,361 in 1927. Freight cars made an average of 389,138 miles between hot boxes in 1934, an increase of 52,223 miles as compared with 1933 and of 302,743 miles as compared with 1927. A total of 3,572,327 miles were made by passenger cars between hot boxes last year, compared with 862,233 in 1927.

Improved maintenance of car and locomotive air brake appliances was reflected in the fact that only 33 pairs of slid-flat freight car wheels were changed last year, as against 64 in 1933, and 1,244 pairs in 1925. The average mileage between such failures was 5,637,834, compared with 2,711,313 miles in 1933 and 222,923 miles in 1925.

Western Railroad Week

THE western railways are extending an invitation to the public to visit railway roundhouses, shops and other plants during the week of June 10-15, so that they may become better acquainted with railroad operation. This is a feature of Western Railroad Week during which the railroads will celebrate the seventieth anniversary of railway progress in the west. As part of the plan, governors and mayors throughout a wide part of the nation have been enlisted to proclaim the week from June 10-15 as Western Railroad Week.

Milwaukee Light-Weight High-Speed Trains

THE Chicago, Milwaukee, St. Paul & Pacific has recently finished 12 more cars on its order of 52, most of which were completed during 1934. These 12 cars, which are now in service on the "Hiawatha" passenger trains operating between Chicago and the Twin Cities, are of the same general design as the six described in the October, 1934, issue of the *Railway Mechanical Engineer*, and are of the electric-welded pan-type steel construction described in the December, 1934, issue, except that one-piece platform and bolster castings have been included; the seat spacing has been revised; the insulation and type of interior finish has been changed; double sash windows have been applied, and air-conditioning equipment installed throughout by the insertion of air-cooling units as provided for in the original design. The cars have an average weight of 113,100 lb., the weight of individual cars varying from 109,000 to 122,500 lb. Equivalent cars of riveted design vary in weight from 163,000 to 179,600 lb.

With the spectacular Milwaukee type steam locomotives described elsewhere in this issue, the 12 cars comprise two six-car-train units which are strikingly beautiful in line and color. The individual cars are non-articulated in construction and may be readily cut in or out of the trains, depending upon traffic requirements. Each train includes a cafe car next to the tender, with a fully equipped kitchen in the rear end, a dining compartment in the center seating 24, a buffet seating 24, and a bar located crosswise in the forward (blind) end; three coaches, each seating 63; a parlor car seating 37, and a rear parlor car seating 39. An illustration of the latter, known as a "beaver-tail" car, was shown on page 123 of the March *Railway Mechanical Engineer*.

The cars for the Hiawatha are of conventional length and cross-section, with the exception that the roof is 1 ft. 4½ in. lower than the former Milwaukee standard.

Power Reverse Gear Case Reopened

ON petition of the complainants—the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen and Enginemen who failed to agree on a program at a meeting in Washington, April 24 and 25—the Interstate Commerce Commission has reopened for reconsideration and further hearing the case in which it ordered the railroads to equip their locomotives with power reverse gear. The original order was set aside by the Supreme Court of the United States on the ground that the commission had not made a specific finding that the mechanical device was necessary for safety.

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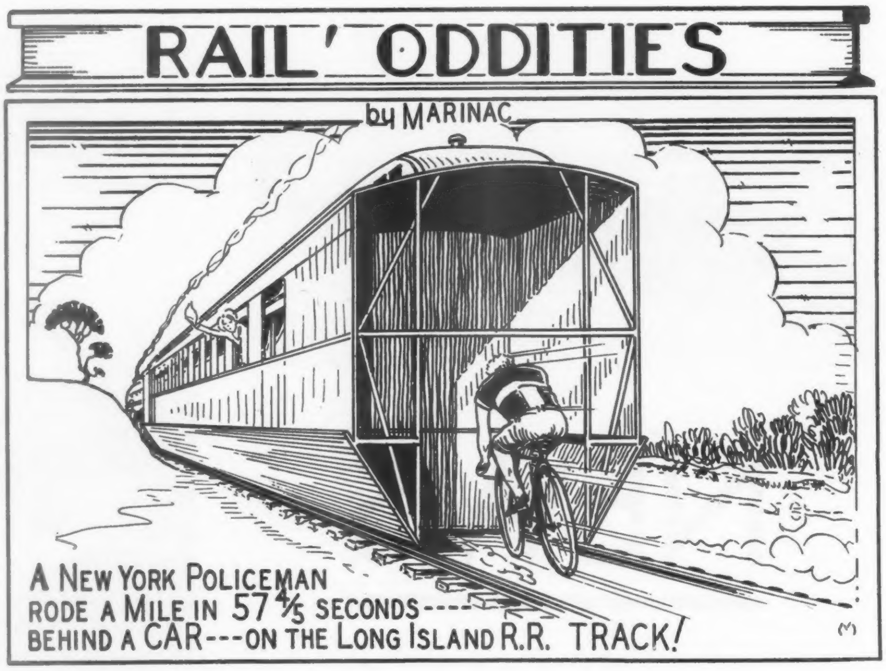

Further information furnished by the Editor upon request

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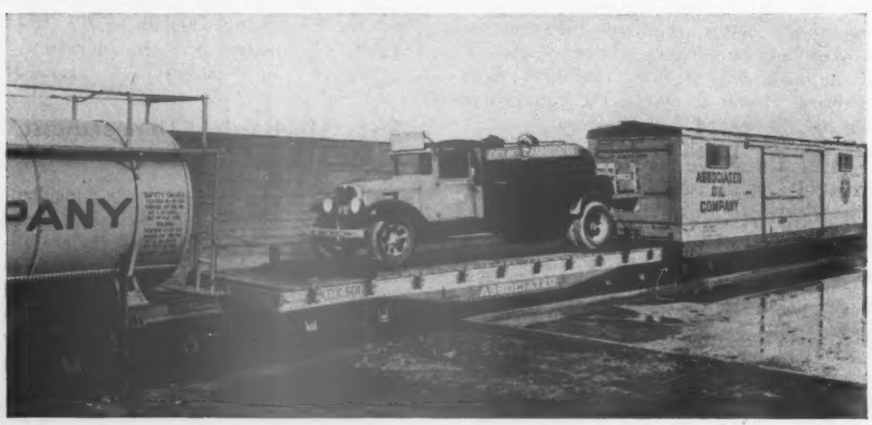

THE ASSOCIATED OIL COMPANY'S PORTABLE DISTRIBUTING PLANT.—A train of four special railroad cars constituting a complete portable distributing plant which can be hauled to the scene of a construction project, has been developed by the Associated Oil Company in order to avoid trucking gasoline and other petroleum products over long distances. The new plant, the first of its kind to be developed, ordinarily comprises two 12,000 gal. tank cars; a flat car on which is carried a tank truck, pumping plant, rails and ties and a portable loading rack; and a specially fitted box car used as a combination warehouse and office. However, any number of tank cars may be used if additional commodities are required by the job.

Supply Trade Notes

THE LUKENS STEEL COMPANY has moved its New York City office from 17 Battery place to the Chrysler building, 405 Lexington avenue.

THE SULLIVAN MACHINERY COMPANY has moved its general offices from the Wrigley building, 400 North Michigan avenue, to the Bell building, 307 North Michigan Avenue, Chicago.

E. P. RAWLE has resigned as director and treasurer of the J. G. Brill Company, and E. L. Oerter has been elected to succeed him in both offices. L. E. Hess is executive vice-president.

D. R. MANUEL has been appointed western manager of the Curtin-Howe Corporation, New York with headquarters at Chicago. He will have jurisdiction over the Minneapolis territory, the Pacific Northwest and Chicago and vicinity.

HARRY F. BOE who has been manager of the Buffalo office of the Westinghouse Electric & Manufacturing Company since 1926, has been appointed assistant manager of the Eastern district with headquarters at New York City.

HORACE M. WIGNEY, vice-president and general manager of Safety Refrigeration, Inc., has moved his office from 230 Park avenue, New York, to 80 East Jackson boulevard, Chicago. The office of J. H. Michaeli, assistant general manager, remains at New Haven, Conn.

NEWTON P. SELOVER has been appointed Pacific Coast representative of the Railway Sales Division of the Consolidated Ashcroft Hancock Company, Inc., a subsidiary of Manning, Maxwell & Moore, Inc., New York, succeeding Fred J. Wilson, who has retired. Mr. Selover's headquarters are at San Francisco, Cal.

A. H. SNYDER, who has for many years occupied the position of designing engineer of the Gould Storage Battery Corporation at Depew, N. Y., has been appointed research and development engineer, in which capacity he will devote his entire time to fundamental problems relating to storage battery projects, design and manufacture.

THE PHILADELPHIA, PA., district sales office of the Republic Steel Corporation, and subsidiaries, the Berger Manufacturing Company and the Union Drawn Steel Company, have been moved from the Fidelity-Philadelphia Trust building to the Broad Street Station building, 1617 Pennsylvania boulevard. J. B. DeWolf continues in charge of the office as district sales manager, assisted by the present staff.

THE REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has moved its New York district sales office to the Chrysler building. W. H. Oliver, district sales manager, is in charge of this office. The export department, under the direction of D. H. Bellamore, general export manager, is also located in the Chrysler building. The company has appointed the Gilmore Steel & Supply Company, San Francisco, Cal., as a warehouse distributor of Enduro stainless steel.

ARMAND H. PEYCKE, who has been in charge of the spring and brake beam departments of the American Steel Foundries, Chicago, has been elected vice-president. Mr. Peycke, who is a graduate of Massachusetts Institute of Technology, has been associated with the company since 1912. He will continue also as president of the Damascus Brake Beam Company, with headquarters at Chicago.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has combined its arc welding manufacturing and technical facilities with those of the Hollup Corporation Sales Service, Chicago. The Westinghouse-Hollup combination establishes a large source of welding equipment and technical service for the railroad industry. Hollup, as exclusive distributor of Westinghouse welding equipment, excepting the Back Bay region of the San Francisco district, has distributing facilities in 19 of the principal cities of the United States and at Toronto and Montreal in Canada.

HERBERT F. SAUER, manager of the Cleveland, Ohio, branch of the Electric Storage Battery Company, Philadelphia, Pa., has been appointed manager of the Chicago branch, and William P. Roche, for many years in charge of the Exide Automotive Replacement division at Cleveland, succeeds Mr. Sauer as manager of the Cleveland branch. Herbert F. Sauer entered the employ of the Electric Storage Battery Company in 1905 at Cleveland; in 1909 he was transferred to the Atlanta, Ga., branch, returning to Cleveland in 1913 and since 1920 he has served as manager of the Cleveland branch. William P. Roche entered the employ of the Electric Storage Battery Company in 1910 and during the last 25 years has served in a number of responsible capacities on the sales staff of the Cleveland branch.

A. M. CANDY has been appointed consulting engineer on the staff of the Hollup Corporation, Chicago, manufacturers of welding wire and supplies and steam railroad distributors for Westinghouse arc welders. He will be engaged in the development of welding machines and other equipment and research and development work in improved welding practice, with particular reference to the application of welding to railroad requirements. Mr. Candy is a graduate of the University of Nebraska and has been associated with the Westinghouse Electric and Manufacturing Company for several years. In the Westinghouse engineering department he has been engaged in the solution of electrical problems involving motion picture projection, storage battery locomotives and arc welding. He has been associated with such developments as the first multiple story welded building, which was constructed in 1926 at the Westinghouse Works at Sharon, Pa., the first arc welded railroad bridge, which is across Thompson Run at Turtle Creek, Pa., and the construction of the Westinghouse engineering laboratory at East Pittsburgh, Pa.

Obituary

W. E. J. GILLAHAN, of the sales department, Railway Steel Spring Division, American Locomotive Company died suddenly on May 20 at New York.

GEORGE F. JONES, for 32 years southern representative for The Baldwin Locomotive Works, died at his home in Richmond, Va., on April 26, at the age of 86 years. Mr. Jones had been on the retired list since January, 1929.

JAMES M. MONROE, vice-president of the Okadee Company and the Viloco Railway Equipment Company, both of Chicago, died at his home at Salisbury, N. C., on May 21. Early in his career Mr. Monroe served the Southern in various mechanical capacities, then entering the supply field as a representative of the Hunt-Spiller Manufacturing Corporation. For the past 15 years he had represented the Viloco Railway Equipment Company and the Okadee Company in the southeast.

TRACY LYON, formerly assistant to president of the Westinghouse Electric & Manufacturing Company, died on April 28 in Lenox Hill hospital, New York. Mr. Lyon was born in September, 1865, at Oswego, N. Y. He served as superintendent of motive power of the Chicago Great Western and later as assistant general manager of that road. In 1906 he became assistant to Edwin M. Herr, at that time vice-president of the Westinghouse Electric & Manufacturing Company, and in 1911 Mr. Lyon went to Detroit, Mich., as director of production of the General Motors Company. Since 1926 he had been chief engineering adviser of the Chrysler Corporation at New York.

EDWARD M. ADAMS, first vice-president in charge of sales and a director of the Inland Steel Company, Chicago, who died at Hot Springs, Ark., on May 8, following a heart attack which occurred on April 24, was born at Cherry Valley, Ill., on December 1, 1876. As a young man, Mr. Adams was in the employ of the Illinois Central and later served a term as mayor of Harvey, Ill. Subsequently, he was employed by the Buda Company, Harvey, as purchasing agent and in other capacities. On June 17, 1907, he entered the employ of the Inland Steel Company as secretary of the company in charge of the credit department and was also active in a sales capacity. In 1918 he was elected a director of the company and, in 1921, became vice-president and secretary. On January 31, 1922, he was elected first vice-president and general sales manager. At the time of his death he was also president of the Deer Creek Mercantile Company and a director of the Indiana Harbor Homes Company. He was a member of the Commercial committee of the American Iron and Steel Institute.

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Personal Mention

Obituary

Edgar Van Court Reinhold, assistant purchasing agent of the New York Central, died on May 9 at his home in Scarsdale, N. Y. Mr. Reinhold was 48.

George H. Schindeldecker, enginehouse foreman of the Chicago, St. Paul, Minneapolis & Omaha, at St. Paul, Minn., died May 13.

John S. Lentz, consulting master car builder of the Lehigh Valley, who was for many years prominently identified with the affairs of the Master Car Builders' Association and its successor, the Mechanical Division, Association of American Railroads, died on May 13 at his home in Lehighton, Pa. Mr. Lentz, who had been associated with the Lehigh Valley for 70 years, was a member of the M. C. B. executive committee as early as 1883 and in 1894-95 served as that organization's president; he was its treasurer from 1910 to 1919 and from the latter date until the time of his death he was a member of the General Committee of the Mechanical Division. Mr. Lentz was born on October 29, 1847, at Mauch Chunk, Pa. He entered railway service in February, 1865, with the Lehigh Valley and served consecutively until August, 1881, as storekeeper, clerk, operator, assistant to master car builder and acting master car builder. From September, 1881, to February, 1889, he was master car builder and from February, 1889, to November, 1897, superintendent of the car department. He was assistant superintendent of motive power from November, 1897, to January, 1900, and from January, 1901, to July, 1928, master car builder. Mr. Lentz became consulting master car builder in July, 1928.

John S. Lentz

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Spring Steel.—A four-page folder, No. 305, issued by the Bethlehem Steel Company, Bethlehem, Pa., describes silicomanganese spring steel having an elastic limot of 165,000 to 190,000 lb. per sq. in.; a tensile strength of 210,000 to 225,000 lb. per sq. in., and an elongation 9 to 12 per cent.

Universal Valves.—The New York Air Brake Company, 420 Lexington avenue, New York, has issued instruction leaflet No. 2356-2 containing instructions on the use of A.R.A. condemning gages for U-12-BD, U-12-BC and U-12-B universal valves.

Packing Rings.—The Hunt-Spiller duplex sectional valve and packing rings and the material from which they are made—Hunt-Spiller air furnace gun iron—are described in four-page illustrated bulletins issued by the Hunt-Spiller Manufacturing Corporation, 383 Dorchester avenue, South Boston, Mass.

Carboloy.—The Carboloy Company, Inc., Detroit, Mich., manufacturers of cemented carbide tools, is distributing a 36-page booklet entitled "Complete Information on the Profitable Use of Carboloy Tools" which describes the benefits which can be obtained from Carboloy tools; the educational work, equipment, etc., necessary to start using the tools; ways in which the material may be purchased, and the physical characteristics of Carboloy. The manufacturing process of this cemented carbide from the raw tungsten ore through to the finished tools is also illustrated.

Stainless Steel.—In the four-page folder issued by the American Rolling Mill Company, Middletown, Ohio, attention is called to the handbook on Stainless Steel Alloys which contains helpful information about Armco stainless steel sheets, plates, strips, etc.

Bakelite.—The Bakelite Corporation, River Road, Bound Brook, N. J., in a 40-page illustrated booklet describes in detail the characteristics, uses and technic involved in the handling of "Bakelite Varnish, Enamel, Lacquer and Cement, Heat Hardenable."

Streamlined Pacific type locomotive on South Manchuria Railway designed to haul a six-car train weighing 353 tons at a top speed of 87 m.p.h.

Weight of engine	262,000 lb.
Weight of engine and tender	448,300 lb.
Cylinders	$23^{5}/_{16}$ in. x $27^{61}/_{64}$ in.
Drivers	78¾ in.
Steam pressure	220 lb.
Evap. heat. surface	2987 sq. ft.
Superheating	1100 sq. ft.
R. T. F.	34,950 lb.